Defra

Expanding Defra's modelling capacity to assess wider impacts of air quality policy (AQ0961)

Technical specification of the model

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1. Introduction

1.1 Technical specification

This report provides a technical description of the modelling tool developed to assess certain wider impacts of air quality policies. It describes the methods used for the calculation of the impacts, including assumptions, limitations and uncertainties. The explanation highlights which parts of the model relate to which aspect of the method. This document intends to facilitate future developments and updates of the model.

The model is also accompanied by a separate User Guide, which provides a less detailed explanation of the key aspects of the model which is sufficient for normal use of the model.

1.2 Scope of the model

The model can be used to assess the following impacts of air quality policies, when relevant to the intervention being assessed:

Table 1.1 Impacts covered within the model

Impact category	Impact	Definition	User inputs required	Output
Distributional impacts	Affordability for business	Change in business' disposable income.	Percentage of businesses impacted Average annualised cost of compliance per business Capital (transitional costs per businesses) Annual operating costs per business (optional) Percentage of businesses able to pass costs Percentage of compliance cost that could be passed Affordability thresholds	Number and percentage of businesses for which the costs of implementation of the measure will have a significant impact.
	Affordability for individuals	Change in households' disposable income.	Change in energy consumption per household Change in domestic fuel prices Capital cost per household for domestic energy use Years over which capital cost is annualised Age of cars affected by the policy Average car lifetime Capital cost per household Change in annual car travel per household Increase in road fuel prices Increase in public transport Increase in average fares per trip	Average cost per household due to changes in transport patterns and price, change in domestic energy consumption and price and capital costs (i.e. scrappage schemes).

Impact category	Impact	Definition	User inputs required	Output
Economic impacts	Employment	Change in jobs	None – Calculated from Affordability for Businesses data	Number of jobs potentially affected
Environmental impacts	Greenhouse gases	Change in emissions of greenhouse gases.	Change in energy consumption (units vary depending on the fuel) Non-fuel GHG emissions (CO_2 eq) Rebound effects (per cent or absolute)	Monetised impact of the change in GHG emissions for traded and non-traded sectors. Also cost per tonne of CO_2e indicator.
Transport specific impacts	Congestion	Change in traffic congestion	Change in vehicle km Location of the change in vehicle km (optional)	Monetised impact of congestion.
	Safety - accidents	Change in accident rates		Monetised impact of accidents.
	Noise	Change in noise levels.		Monetised impact of noise.
	Modal shift	The change in trips made by alternative modes of transport in response to the scheme.		Change in the number of trips per mode of transport and area
	Health impacts from walking and cycling	Reduced morbidity through increased health and fitness from using active modes of transport.	Number of cycling and walking journeys due to the policy Average length of journey and speed A number of control options are populated by default but can be changed by the user.	Monetised impacts of health impacts.

2. General model description

2.1 Structure of the model

The schematic diagram presenting key elements of the model is illustrated in Figure 2.1 below. The model operates in Microsoft Excel 2013, contained within a single file with no interlinked spreadsheets.

The model contains a number of Control sheets in which the user enters input data specific for the policy assessed or selects options from drop down lists. For majority of the impacts, there are dedicated Control sheets developed in the model. That is because there is generally little overlap in the user inputs required for the assessment of individual impacts and for some impacts there are a large number of input parameters required. The Control sheets are the main interface for the user.

There are subsequent data sheets containing fixed inputs. These should be updated by the user when updated underlying data sets are published. A Reference sheet provides a list of all the reference sources and weblinks of the fixed input data to assist the user for this updating process. Several fixed inputs for the calculations have been provided by Department for Transport for the purpose of the model specifically. These sources are not expected to be available in the public domain in the future and as such the ability for the user to update them will rely on obtaining the data from DfT or other relevant stakeholders. Inputs for which this is the case have been clearly indicated in the model.

Both the user-defined and the fixed inputs tables require entry of data in the appropriate units, format, year etc. as per the headings and labels. Often the user is given the flexibility to choose from a selection of possible units when entering the inputs.

Calculations for the assessment of each impact are each presented in a separate sheet. There is little interaction between different impacts and so calculations are performed independently. An exception is the impacts of modal shift which is linked to health impacts of walking and cycling. Data from the Control and Inputs sheets are imported into the Calculation sheets, as relevant for the assessed impact, based on the options selected in the Control sheets. The next steps calculate the quantified values and then (where applicable) monetise these values, in accordance to the methods specified in the Technical Specification.

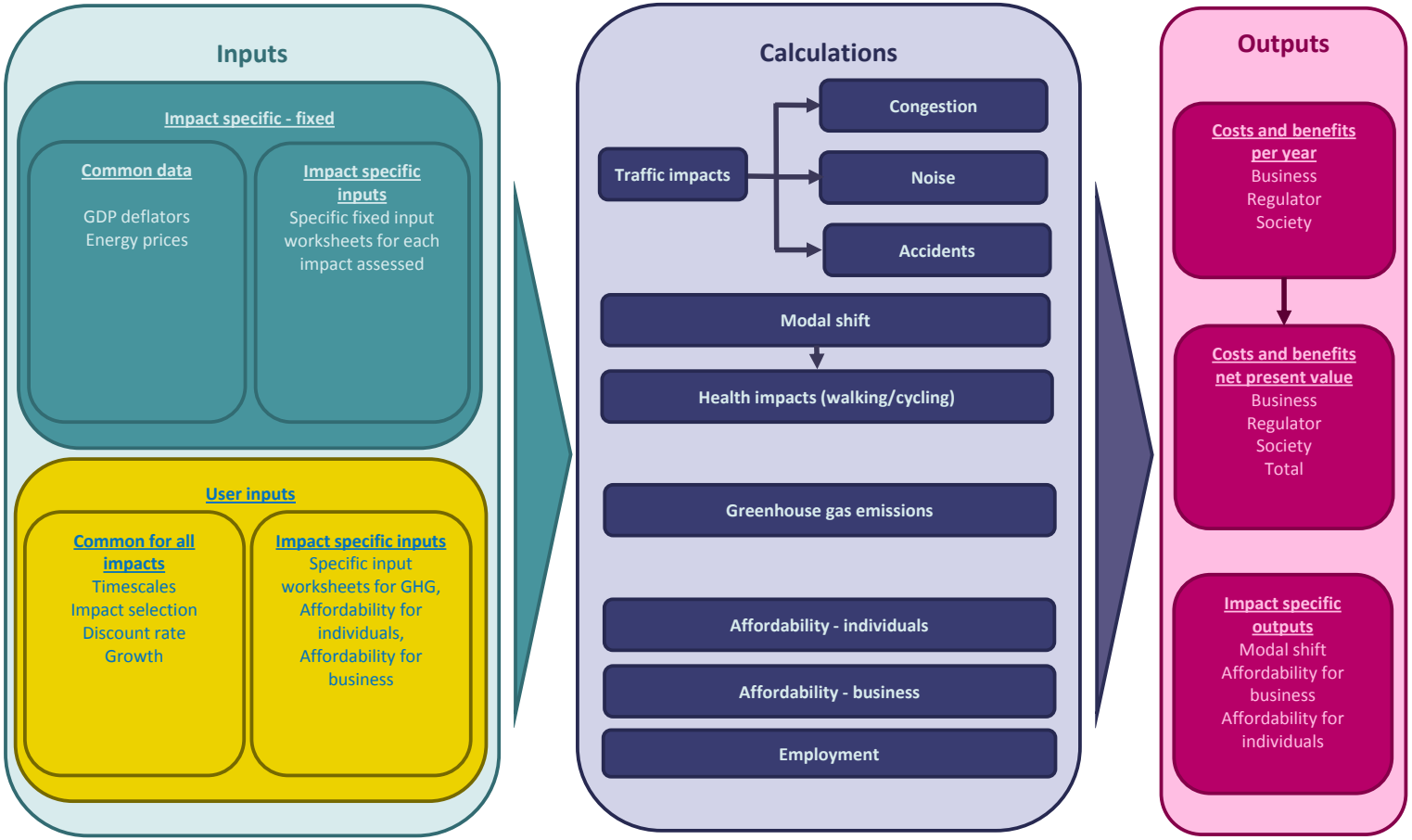
Intermediate outputs are presented for each impact separately showing the transitional and recurring costs and benefits for most impacts. This is to allow the user to extract these data, and when relevant add them to equivalent data on costs of other direct or indirect impacts which may be estimated using bespoke methods outside of this model. For certain impacts it is not possible to monetise the impact and therefore alternative, appropriate presentation of quantified impacts is presented. This is discussed in sections on individual impacts below.

The output costs and benefits, or other numerical results, for each impact are presented in a Results summary sheet so the user can see each of the impacts that are relevant for the measure assessed[1]. For impacts for which monetisation is possible, the net present value (NPV) of the costs for each impact is calculated and presented using a consistent approach to the Impact Assessment Calculator (BIS, 2013). Where possible the results distinguish between the impacts on the regulator, businesses and society. In the Control sheet, the user has the option to select different discount rates and assessment periods to suit the purpose of the appraisal.

Uncertainty is assessed using two parallel systems, quantitative and qualitative. The quantitative system uses three different set of user outputs corresponding to central, low and high scenario. The qualitative system is based on uncertainty scores awarded to every input and propagated through the calculations and results. More details are provided in Section 11.

[1] The costs are not summed up to avoid misleading a user into thinking that these costs are the total costs from all wider impacts. There are several impacts for which it has not been possible to develop a generic method to estimate the costs and in a regulatory impact assessment, depending on the policy lever under consideration, these costs may need to be calculated by other means.

Figure 2.1 Conceptualisation of the model



A summary of the worksheets in the model is presented in Table 2.1. The model is structured using five types of sheets depending on their function and colour coded as displayed below.

Table 2.1 Key elements of the model

Tab function	Sheet name	Description
Version log	Version	Provides a log of major changes during the development of the spreadsheet, a QA register and status and a colour key used across the model.
Instructions	Overview	Summary flow chart of the model
References	References	Register of reference sources used for fixed inputs
Control – user inputs	Control	Information, data and selection of inputs to be entered by the user Currently include inputs to be entered by user of the model for assessment of traffic related impacts
	Control-GHG	Additional control sheet to allow for large volume of inputs that may be entered by the user to assess impact on greenhouse gases.
	Control-Business Affordability	Additional control sheet to allow for large volume of information that may be entered for Business Affordability
	Control – Indiv Affordability	Additional control sheet to allow for large volume of information that may be entered for the assessment of Affordability for Individuals.
Fixed inputs	Inputs-Common data	Input data common to several impacts: - GDP deflators - Fuel prices - Ranges for the classification of final uncertainty
	Inputs-traffic	Input data assess transport impacts: - Traffic shares by region and time - Marginal External Costs by region and time - Traffic by region, congestion band, area and road type - Marginal External Costs by congestion band and road type - Trip change per additional 1,000 car km change, by area type - Factors for health benefits impact
	Inputs-GHG	Input data for the assessment of GHG impacts: - Electricity emission factors - Average emission factors per sector - Gaseous, liquid and solid fuels emission factors - Transport emission factors (2014) - Fuel properties - Conversion factors from user input units to kWh for selected fuels (2014) - Conversion factors from user input units to litres of fuel for transport (kWh in the case of electric transport) (2014) and units after conversion - Carbon prices and sensitivities (low, central and high) for appraisal (£/tCO2e) - Long-run variable costs of energy supply (LRVCs) - Retail energy prices
	Inputs-Business Affordability	Input data for affordability to business assessment: - Numbers, employees and turnover of businesses by industry division - Gross operating surplus and mixed income
	Inputs-Employment	Fixed inputs for the assessment of employment

Tab function	Sheet name	Description
	Inputs-Afford Individuals	Fixed inputs for the assessment of individual affordability impacts
Calculations	Calculations-Congestion	Calculations for assessment of congestion
	Calculations-Noise	Calculations for assessment of noise
	Calculations-Accidents	Calculations for assessment of impacts on accidents
	Calculations-Modal Shift	Calculations for assessment of modal shift
	Calculations-Health Impacts (MS)	Calculations for assessment of health impacts of cycling linked to modal shift assessment
	Calculations-Health Impacts (SA)	Calculations for assessment of health impacts as a standalone assessment
	Calculations-GHG (central)	Calculations for assessment of greenhouse gases impact for the central scenarios.
	Calculations-GHG (low)	Calculations for assessment of greenhouse gases impact for the low scenarios.
	Calculations-GHG (high)	Calculations for assessment of greenhouse gases impact for the high scenarios.
	Calcs-Business Affordability (central)	Calculations for assessment of affordability to business for the central scenarios.
	Calcs-Business Affordability (low)	Calculations for assessment of affordability to business for the low scenarios.
	Calcs-BusinessAffordability (high)	Calculations for assessment of affordability to business for the high scenarios.
	Calcs-Employment (central)	Calculations for assessment of employment for the central scenario.
	Calcs-Employment (low)	Calculations for assessment of employment for the low scenario
	Calcs-Employment (high)	Calculations for assessment of employment for the high scenario
	Calcs-AffordIndiv(Transport)	Calculations for assessment of affordability for individuals for policies affecting household travelling patterns.
	Calcs-AffordIndiv(Domestic)	Calculations for assessment of affordability for individuals for policies affecting domestic use of fuel.
Outputs	Results-Congestion	Summary of costs and benefits by year for congestion impact
	Results-Noise	Summary of costs and benefits by year for noise impact
	Results-Accidents	Summary of costs and benefits by year for congestion impact
	Results-Modal shift	Summary of change in a number of trips by mode of transport and year Total change in the number of trips per mode for the whole appraisal period
	Results-Health Impacts	Summary of costs and benefits to human health from increased cycling presented for the assessment linked to modal shift and the standalone assessment (new users and existing uses)
	Results-GHG	Summary of total monetised costs and benefits for the GHG impact
	Results-Business Affordability	Summary of numbers and percentages of businesses with significant impact by company size and industry division
	Results-Employment	Summary of results for assessment of employment impact
	Results-Indiv Affordability	Summary of results for assessment of affordability for individuals
	Results-Summary	Aggregated summaries of main results for each impact

Throughout the spreadsheet the following text colours are used to clearly indicate whether values in calls are typed inputs, cross linked values referenced from another part of the spreadsheet or calculated values (differentiating between main calculations and in-built cross checks). User defined inputs should be entered in yellow shaded cells.

Table 2.2 Key for text colours used in the model

Key
User input variable
Blue = fixed inputs
Black = calculations
Green = direct cross reference
Red = warning
Grey = cross-checking

2.2 Spreadsheet functionality

"+" and "-" symbols in the margins of the worksheets (see example in Figure 2.2) can be clicked to expand or hide rows and columns. These have been included to compress the worksheets and hide cells that may be empty or redundant if not used in that assessment. Expanding rows or columns may be necessary to allow for entry of additional rows of data. Users are not expected to insert or delete rows from the model. However if new rows and columns are inserted in the model, both the User Guide and the Technical Specification for the model need to be updated with new cell references.

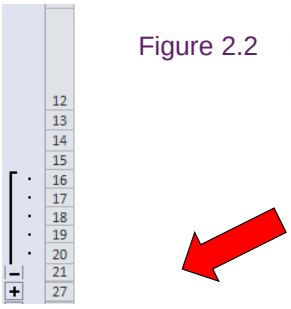


Figure 2.2 Expanding and hiding the rows in the spreadsheet

2.3 Spreadsheet protection

With the exception of the control tabs (**Control, Control-GHG, Control-BusinessAfford** and **Control-Affordindiv**) all the worksheets in the file have been protected. This is to avoid the user to inadvertently modify the equations and inputs. No password has been set to unprotect the sheets. If the user wants to make changes in a protected sheet he or she just needs to click on the button "Unprotect sheet" in the ribbon under the "Review" category.

3. Economic aspects of the methodology common for several impacts

3.1 Appraisal period

According to the HMT Green Book the appraisal period for cost and benefit assessment should 'cover the period of usefulness of the assets encompassed by the options under consideration'.

The user of the model is required to input the current year the assessment is undertaken against (to determine price base year), the start year of the measure and the end year of the appraisal period over which the costs and benefits of the proposal are to be assessed and the year the costs are to be inflated/deflated to. The user of the model will have ultimate responsibility for selecting an appropriate appraisal period for the type of policy measure under assessment. The appraisal period could be taken to be the lifetime of the policy/measure or the economic lifetime of technologies taken up for compliance.

Box 1 Appraisal period

To apply appraisal period to the impacts calculation in the model, the user is required to input the appropriate timescales into the **Control** sheet Rows 11-15 for the current year of assessment, policy measure start year, the assessment end year and the costs considered to be inflated/deflated to.

Timescales		
Current year	2015	
Measure start year	2020	
Assessment end year	2030	
Costs to be inflated/deflated to	2014	prices

Control sheet Rows 17:32 show the list of impacts covered by the tool and provides a series of hyperlinks to the different sections assisting the user in navigating the model.

Impacts covered in this model

	Go to:					
Transport related impacts						
Congestion	Input (to enter)	Inputs (fixed)	Calculations	Results		
Safety / accidents	Input (to enter)	Inputs (fixed)	Calculations	Results		
Noise	Input (to enter)	Inputs (fixed)	Calculations	Results		
Modal shift	Input (to enter)	Inputs (fixed)	Calculations	Results		
Health impacts of walking and cycling	Input (to enter)	Inputs (fixed)	Calculations 1	Calculations 2	Results	
Environmental						
Greenhouse gas emissions	Input (to enter)	Inputs (fixed)	Calculations 1	Calculations 2	Calculations 3	Results
Distributional impacts						
Affordability for business	Input (to enter)	Inputs (fixed)	Calculations 1	Calculations 2	Calculations 3	Results
Employment		Inputs (fixed)	Calculations 1	Calculations 2	Calculations 3	Results
Affordability for individuals	Input (to enter)	Inputs (fixed)	Calculations 1	Calculations 2	Results	

3.2 Cost inflating

Gross Domestic Product (GDP) deflators, which can be viewed as a measure of general inflation in the domestic economy, will be used to inflate/ deflate any direct cost inputs to the year of the assessment. The user will be required to specify the year for which the input costs are provided.

Box 2 Cost inflating

The GDP deflators are stored in the **Inputs-Common data** sheet (Rows 6:58). These values are used to represent costs in the price of a given year, taking into account historical and/or predicted inflation. Current values reach up to 2014. Values from 2015 to 2018 have been inferred using the available percentage changes in line with the March 2014 Budget. In future years as new GDP deflator values become available (see https://www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp) these can be replaced with factual ones.

GDP deflators at market prices

Outturn data are the latest National Accounts figures from ONS - Last updated 6 October 2014
Forecast data are consistent with OBR Budget data 19 March 2014

Calendar year	2013 = 100	per cent change on previous year
1985	41.272	6.12
1986	43.056	4.32
1987	45.326	5.27
1988	48.016	5.94
1989	51.868	8.02
1990	56.076	8.11
1991	59.751	6.55
1992	61.705	3.27
1993	63.293	2.57
1994	64.066	1.22
1995	65.650	2.47
1996	68.293	4.03
1997	70.205	2.80
1998	71.258	1.50
1999	72.069	1.14
2000	73.799	2.40
2001	74.605	1.09
2002	76.579	2.65
2003	78.244	2.17
2004	80.521	2.91
2005	82.778	2.80
2006	85.004	2.69
2007	87.445	2.87
2008	89.984	2.90
2009	91.766	1.98
2010	94.677	3.17
2011	96.689	2.13
2012	98.294	1.66
2013	100.000	1.74
2014	102.300	2.30

3.3 Discount rate

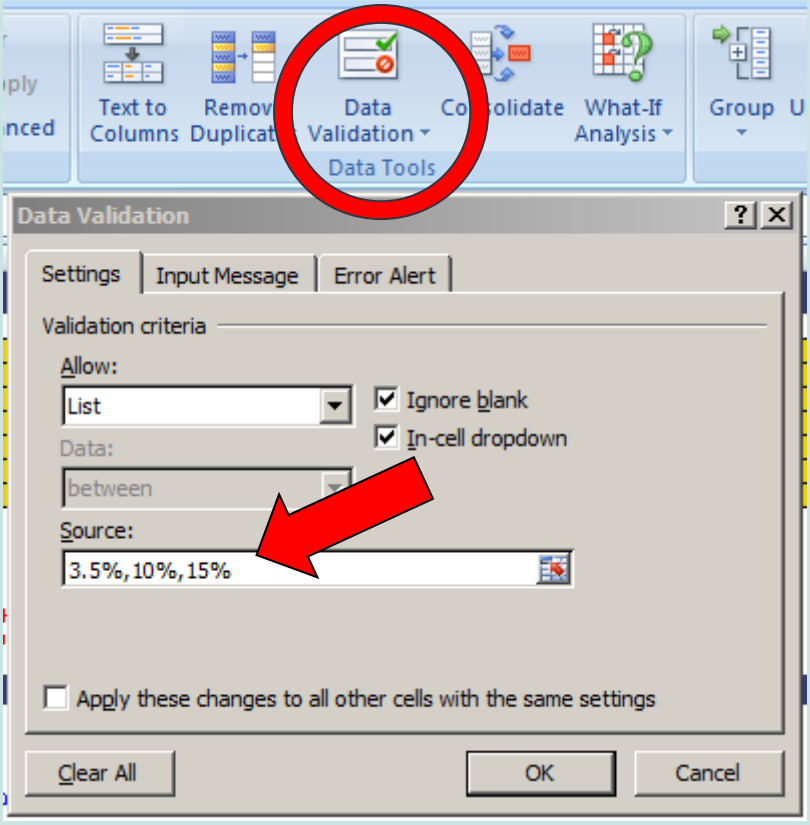
The discount rate of 3.5% as recommended in the HMT Green Book is proposed as a default discount rate to be used in the model. This is selected on the assumption that the timeframes of the policies to be assessed in the model will be less than 30 years. In order to provide flexibility to use the model to assess the impacts over a longer period of time, the declining long term discount rates as provided in the HMT Green Book is pre-coded in the model (these decline to 3% for the appraisal period 31-75 years). In addition, an option for the user of the model to select higher discount rates is included; the pre-coded values proposed are 7%, 10% and 15%. These higher discount rates may be selected for scenarios assessing policies expected to have significant impacts on businesses, as they are closer to the rates businesses would apply when considering new investment.

Box 3 Discount rate

The discount rate is selected by the user from a drop down list in **Control** (C35).

To change the options in the drop down menu, select the cell and click on "Data Validation" in the Data ribbon.

In the Data Validation pop-up window change the values in the "Source" box as required, then click on "OK".



The discount rate links into the calculation sheets for each monetised impact to calculate the PV and NPV cost/benefit. This is explained in further detail for each impact in the respective sections below.

3.4 Net Present Value

To reflect the "time preference" concept[2], each monetised impact is expressed using the Net Present Value. The discount factor is calculated according to the following equation as presented in the HMT Green Book:

$$Dn = \frac{1}{(1+r)^n}$$

Where: n – year of the assessment; r – discount rate; D_n – discount factor

The discount factor is applied to calculate the present value for cost/benefit for each year of the assessment period. The sum of the discounted costs/benefits for the whole assessment period is taken as the NPV.

[2] The fact that in principle people prefer to receive goods and services now rather than later.

3.5 Presentation of costs and benefits

The Wider Impacts model does not calculate direct compliance costs. These are considered inputs to the model (relevant to assessment of affordability on business and on individuals).

The model has been developed so the resulting costs/ benefits of the measures could be presented as:

- **Transitional** costs/ benefits – one off cost/ benefit usually in the first year of the policy or measure in order to achieve compliance with the policy; and
- **Annual** costs**/** benefits – re-occurring annual cost/ benefit resulting from compliance with the policy or measure; these may differ from year to year.

This is to enable the user to directly transfer the outputs of the model to the Impact Assessment Calculator (BIS, 2013)[3]. However, it has only been possible to calculate transitional costs for Affordability for individuals. The current structure has been retained in order to allow for these detailed costs to be easily incorporated in future model improvements.

The general structure of the formulae used in the individual result sheets is: If the year in the column heading is lower than the assessment start year or higher than than the assessment end year, "No data" (or blank) is displayed. The same is displayed for costs if the results are lower than zero (meaining a benefit) and for benefits if higher than zero (meaning a cost). This way only positive and negative numbers are displayed for costs and benefits respectively. This structure, with some variations, is applied in the individual result sheets for all impacts except Affordability for businesses and Employment.

Box 4 Presentation of summary results - costs and benefits

Each impact has a separate results worksheet which is described in individual impact sections in this document.

Input data of the appraisal period is fed from **Control** sheet (Rows 11-15). In each of the **Results –"impacts"** the results are further colour coded as current year, measure start year, appraisal end year to aid with the interpretation of results. In each of these impacts results sheets, the data is fed into the **Results-Summary** sheet.

Units:	£'000s		2015	2016	2017	2018	2019	2020	2021
Costs	Transition cost	Central							
		Low							
		High							
	Annual cost	Central	No data	No data	No data	No data	No data	No data	6709.32
		Low	No data	No data	No data	No data	No data	No data	3412.01
		High	No data	No data	No data	No data	No data	No data	10002.54
Benefits	Transition benefit	Central							
		Low							
		High							
	Annual benefit	Central	No data	No data	No data	No data	No data	No data	No data
		Low	No data	No data	No data	No data	No data	No data	No data
		High	No data	No data	No data	No data	No data	No data	No data

The summary of costs and benefits, distinguishing between costs/ benefits to business, regulator and society, and between the transitions, annual and total annualised costs are then presented in **Results-Summary.** Total Net Present Value is calculated for each impact.

[3] Available from https://www.gov.uk/government/publications/impact-assessment-calculator--3

Box 4 Presentation of summary results - costs and benefits

Results - Summary

This worksheet contains a results summary for the following impacts:

Congestion
Noise
Accidents
Health impacts of cycling
Business affordability
other impacts to be inserted as per these examples

Additional results to be shown where possible to calculate these

Return to Control - user inputs

Congestion

npv 2014 prices £'000s	Costs									Benefits									Total Net Present Value			Comments
	Total Transition			Average Annual			Total annualised costs			Transition benefit			Annual benefit			Total annualised benefits						
	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	
Impact to business Impact to regulator Impact to society																						Impacts on congestion could not be dissagregated. They are presented as total impact.
Total impact				-	-	-	-	-	-				- 166	- 125	- 266	- 166	- 125	- 266	-165.6	-125	-266	

Noise

npv 2014 prices £'000s	Costs									Benefits									Total Net Present Value			Comments
	Total Transition			Average Annual			Total annualised costs			Transition benefit			Annual benefit			Total annualised benefits						
	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	
Impact to business Impact to regulator Impact to society																						Impacts on noise could not be dissagregated. They are presented as total impact.
Total impact				-	-	-	-	-	-				- 1	- 1	- 1	- 1	- 1	- 1	-1	-1	-1	

4. Method to assess congestion, noise and safety impacts

4.1 Overview

The primary method for estimating the impacts on congestion, noise and safety of the potential future policy interventions, in the absence of a multi-modal model, is based on marginal external costs (MECs). For vehicle use, these external costs include congestion, air pollution, noise, and infrastructure and accident costs. The MEC method is based on the change in these external costs arising from an additional (or removed) vehicle (or vehicle km) on the network[4].

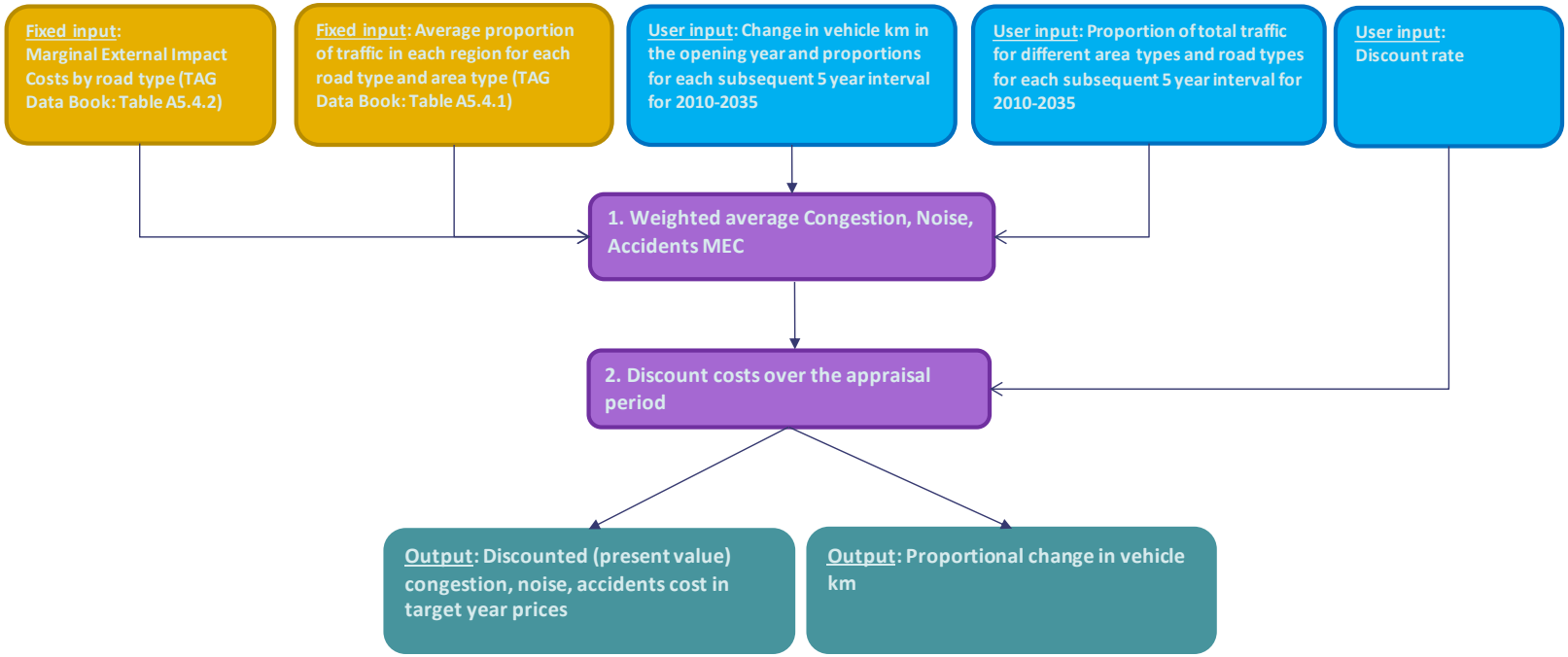
For the impacts of Congestion, Safety/ Accidents, and Noise, the WebTAG Marginal External Cost (MEC) approach is used from TAG unit A5.4 which uses the TAG Data book (from May 2014). The WebTAG A5.4 MEC method was selected as it is part of official UK Government (DfT) guidance, and is a proportionate approach suitable for the current tool. The following sections outline the same process for all impacts, indicating clearly where the method differs for specific aspects.

The WebTAG A5.4 MEC method is superior to a generic elasticity-based method (which would attempt to determine a high-level relationship between kilometres reduced and level of congestion/noise/accidents), as it is the result of the modelling of regional traffic flow levels and congestion levels within the National Transport Model (NTM), and as such provides a useful shortcut to the relevant impact parameters based on the region, area type, and existing road congestion levels. An overview of the methodology to calculate the impacts are presented in Figure 4.1 below.

No significant adjustments have been made in order to build the WebTAG A5.4 MEC approach into the tool. Data from WebTAG currently covers up to 2035. However, updates to future versions of the relevant parameters (which are typically released annually) are facilitated through consistency in format with the new and convenient TAG data book Excel spreadsheet.

[4] TAG UNIT A5.4 Marginal External Costs, Department of Transport, January 2014

Figure 4.1 Overview of the methodology to assess impacts on congestion, noise and safety/accidents



4.2 Inputs

Inputs used to calculate the impacts on congestion, noise and safety / accidents are summarised in Table 4.1 below.

Table 4.1 Summary of inputs – congestion, noise, safety/ accidents

Input	Units	Comment	Source
User Inputs:			
Change in vehicle km	veh km	The user enters an estimate of the net change in vehicle kilometres due to the intervention. As a minimum, it has to be entered for each 5 year interval for the assessment period but if detailed inputs are available user can expand rows and enter them. Empty rows in Control "Table 1" (rows 46:91) provide space for user inputs after 2035 in case an update of WebTAG includes further projections.	Assessment of the measure
Proportion of total traffic for different area types and road types	Percentage per area and road type	This is determined by the extent to which vehicles are diverted off (or onto) different road and area types by the air quality policy. The user can enter the percentage distribution of traffic between each area and road type for each 5 year interval. If this detail for the location of the change in vehicle km is unknown the user can select the geographic region and average values for the region will be applied to allow for calculation of the impact of the net change in vehicle kms. For general cases, where no specific area is needed, Great Britain must be selected as the highest level of aggregation available.	Assessment of the measure
Discount Rates	Percentage discount	Discount rate selected by the user is used to calculate the present value of costs for each year in traffic demand over the appraisal period will be used for the final result	User selection
Fixed Inputs:			
Marginal External Impact Costs by road type	pence per km, (undiscounted market prices)	Costs are converted to the specified price base by multiplying by the GDP deflator value in the price year and dividing by the GDP deflator for the source year.	TAG Data Book –Table A5.4.2
Average proportion of traffic in each region for each road type and area type	Percentage weightings of total traffic	The primary limitation is that lack of a highway model will result in using regional averages from the National Transport Model (NTM)	TAG Data Book –Table A5.4.1

The **user inputs** required to calculate the impact are:

- **Change in vehicle km**: Changes in number of vehicle kilometres can be direct impacts of air quality measures. These data have to be provided by the user of the model[5]. In the absence of local evidence, estimates of regional traffic flows derived from the NTM can be used.

Box 5 Change in vehicle kilometres

Change in vehicle kilometres are to be entered by the user in **Control** "Table 1" (rows 41:91). As a minimum it has to be input for every 5 year interval. If user inputs for individual years are available, these can be input in the collapsed rows. Central, low and high values can be entered and all are carried through into the calculations and presentation of the results.

Alternatively the user can select a qualitative uncertainty indicator, for which a numerical value is automatically assigned. The numerical value is carried through the calculations and results to be combined with the uncertainty score of other input parameters in order to provide an indication of the uncertainty level of the results.

Table 1 Change in vehicle kilometers for traffic impacts (for UK)

Year	Change in vehicle kilometers			Uncertainty		Comments	Reference
	Central	Low	High	Qualitative	Score		
	veh km	veh km	veh km				
2010	-	-	-	not used	1		
2015	7,000	4,000	12,000	not used	1		
2020	5,000	2,000	10,000	not used	1		
2025	-5,000	-2,000	-7,000	not used	1		
2030	-36,000	-30,000	-60,000	not used	1		
2035	-30,000	-25,000	-50,000	not used	1		

← Ungroup to expand more input rows

These data are carried forward into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** for the selected assessment period duration (rows 9:54).

- **Proportion of total traffic for different area types and road types**: A shift in the location of vehicle kilometres between different area and road types can be a direct impact of an air quality measures. These data can be provided by the user of the model.
- However, if these data are not available the user can instead select the geographical region in which the change in vehicle km occur and default average distribution of traffic for that region is applied. The details of geographic areas used in the wider impacts model are provided in Appendix A.

[5] For short distance trips, the change in vehicle km data can be obtained by passenger surveys, whereas for long distance trips the data can be obtained from National Transport Statistics Database (TAG Unit A5.4 Marginal External Costs)

Box 6 Proportion of total traffic for different area types and road types

The distribution of the change in vehicle kilometres across different areas and road types can be entered in **Control** "Table 2 (Optional)" (rows 99:107) along with the associated five year interval years. The numerical value is carried through the calculations and results to be combined with the uncertainty score of other input parameters in order to provide an indication of the uncertainty level of the results. A check cell for every year is present in column N. If Table 2 is used, this check should show 100% for every year containing data.

Table 2 (Optional) **Proportion of total traffic for different area types and road types**

If the user does not specify the proportion of total traffic for area and road types, standard values will apply according to the selected regio

Year	London Motorways	London A Roads	London Other Roads	Inner and Outer Conurbations Motorways	Inner and Outer Conurbations A Roads
	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic
2010					
2015					
2020					
2025					
2030					
2035					

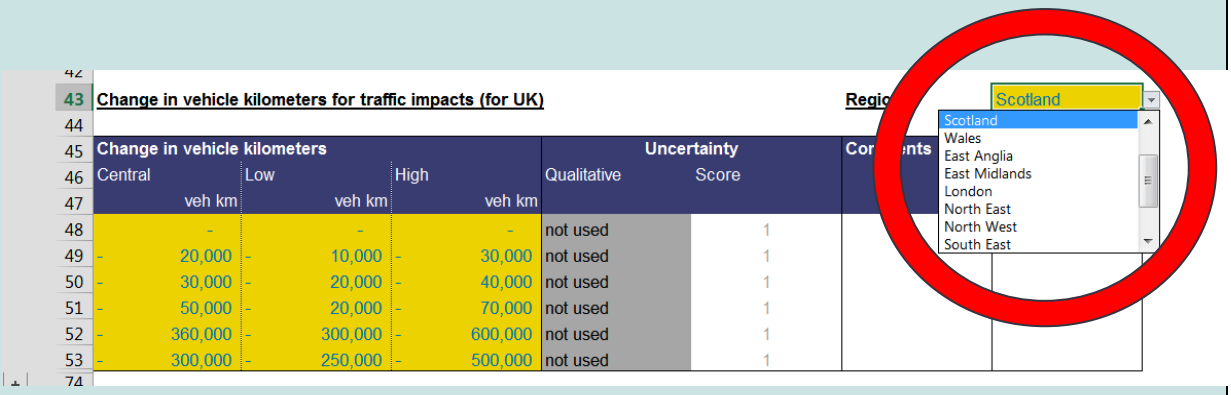
Unit: **% of total traffic**

)n.

Inner and Outer Conurbations Other Roads	Other Urban A Roads	Other Urban Other Roads	Rural Motorways	Rural A Roads	Rural Other Roads	Uncertainty Qualitative	Uncertainty Score
% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic		
						medium	3
						medium	3
						medium	3
						medium	3
						medium	3
						medium	3

These data are carried forward into **Calculations-Congestion**, **Calculations-Noise, Calculations-Accidents** for the selected assessment period duration (row 61:69).

Alternatively the user can select the geographical region in which the change in vehicle kilometres occurs from the drop down menu (cell I41) in Control "Table 1" (row 41). The highest level of data available is for Great Britain. No data for UK level is available in WebTAG.



The categories in this drop down menu are based on WebTAG. To change the options in the drop down menu, select the cell and click on "Data Validation" in the Data ribbon. In the Data Validation pop-up window, in the field "Source", the user can see the reference range for the list of regions (**Control,** cells L44:L56). To update the list of regions, type in the new region names in the reference cells. If the new list is longer, please update the reference range in the "Source" box as required, then click on "OK".

This data is carried forward into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (cell H5). The traffic data relevant for the selected region are then populated in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 61:69).

The categories for the area and road type, and the list of geographic regions, are compatible with the fixed inputs (described below) and therefore should only be changed if the format of the fixed inputs is changed.

The **fixed inputs** required to calculate the impact are:

- **Average proportion of total traffic for different area types and road types:** The proportions of traffic for each road type and area type vary by region and are given in Table A5.4.1, TAG Data Book. Proportions of traffic are given for 2010 and five year intervals to 2035.

Box 7 Proportion of total traffic

Average traffic proportions are presented in **Inputs-traffic** (rows 8:109). Separate tables are provided for each five year interval from 2010 to 2050. The categories and format is consistent with WebTAG Table A 5.4.1, from which data for 2010-2035 has been extracted (2040-2050 data are not yet available but the tables for these years have been included for when this data is available).

Proportion of total traffic for different area types and road types

		2010LondonMo	2010LondonA R	2010LondonOth	2010Inner and C	2010Inner and C	2010Inner and C	2010Other Urba	2010Other Urba	2010RuralMoton	2010RuralA Ro	2010RuralOther Roads	
		2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
2010 Proportion of Total Traffic in each congestion band for different regions, area types and road types (1 d.p.)													
Region	Congestion band	London Motorways	London A Roads	London Other Roads	Inner and Outer Motorways	Inner and Outer A Roads	Inner and Outer Other Roads	Other Urban A Roads	Other Urban Other Roads	Rural Motorways	Rural A Roads	Rural Other Roads	Grand Total
	1	0.1%	0.3%	1.1%	0.7%	1.2%	3.9%	2.2%	8.1%	2.8%	11.4%	11.3%	**43.0%**
	2	0.2%	0.8%	0.7%	1.8%	2.2%	1.6%	4.4%	2.8%	6.5%	9.0%	1.7%	**31.6%**
	3	0.0%	1.0%	0.3%	1.7%	1.5%	0.8%	3.3%	1.1%	4.1%	2.2%	0.5%	**16.6%**
	4	0.0%	1.0%	0.3%	0.5%	1.2%	0.7%	1.9%	0.5%	0.6%	0.5%	0.3%	**7.5%**
	5	0.0%	0.3%	0.1%	0.0%	0.1%	0.1%	0.4%	0.0%	0.0%	0.0%	0.2%	**1.2%**
Great Britain	**Average**	**0.3%**	**3.5%**	**2.5%**	**4.6%**	**6.2%**	**7.1%**	**12.3%**	**12.5%**	**14.0%**	**23.1%**	**14.0%**	**100.0%**

Although the geographical scope for the Wider Impacts model is the whole of the UK, the best available information in WebTAG is for Great Britain. It is recommended to use Great Britain for general cases. Data for lower level geographical regions is included in the model should the user have information on the region in which the intervention occurs.

If the user is not able to provide this distribution of the net change in vehicle kilometres in the Control tab, then the relevant region can be selected and default values applied. As these default values are based on the counterfactual this does not allow for assessment of the impact of change in location of vehicle kms – it only allows for assessment of the impact of the net total change in vehicle kms. When applied, these data are carried forward into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 9:54) for the selected assessment period duration.

- **Marginal External Costs:** The WebTAG Marginal External Cost (MEC) for congestion, noise and safety/accidents are given in WebTAG Table A5.4.2. They are given for 2010 and five year intervals to 2035. They offer a monetised estimation of costs associated with the number of vehicle kilometres.

Box 8 Marginal External Costs (MEC)

MEC are presented in **Inputs-traffic** (rows 113:128). Separate tables are provided for each five year interval from 2010 to 2050. The categories and format is consistent with WebTAG Table A 5.4.1, from which data for 2010-2035 has been extracted (2040-2050 data are not yet available but the tables for these years have been included for when this data is available). For congestion, only average MEC values are used, not considering congestion bands (in collapsed rows).

Marginal External Costs (MEC) by road type

2010 Marginal External Costs & Indirect Tax - Cars (pence per car km, 2010 prices, 1 d.p.)													
		London			Inner and Outer Conurbations			Other Urban		Rural			
Cost type	Congestion band	Motorways	A roads	Other Rds	Motorways	A roads	Other Rds	A roads	Other Rds	Motorways	A roads	Other Rds	Weighted Average
Congestion*	Average	**0.1**	**67.1**	**46.4**	**2.8**	**34.2**	**23.8**	**13.2**	**10.8**	**1.1**	**2.2**	**2.7**	**11.5**
Infrastructure	All	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	**0.1**
Accident	All	0.0	3.0	3.0	0.0	3.0	3.0	3.0	3.0	0.0	0.7	0.7	**1.6**
Local Air Quality	All	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	**0.1**
Noise	All	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.1	**0.1**
Greenhouse Gases	All	0.9	1.0	1.2	0.9	0.9	1.0	0.8	0.9	0.9	0.8	0.8	**0.9**
Indirect Taxation	All	-5.3	-5.6	-7.1	-5.2	-5.2	-5.7	-4.8	-5.4	-5.3	-4.8	-4.7	**-5.1**
Total		**-3.8**	**66.1**	**44.1**	**-1.1**	**33.3**	**22.5**	**12.6**	**9.7**	**-3.2**	**-1.0**	**-0.3**	**9.2**

These data are carried forward into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 70:78) for the selected assessment period duration.

4.3 Calculations

Calculations are undertaken in the following worksheets: **Calculations-Congestion, Calculations-Noise, Calculations-Accidents.** The assessment method is comprised of the following steps:

- Step 1: Weighted average Congestion, Noise, Accidents MEC

In this step the weighted average congestion, noise, accidents MEC (depending on the impact assessed) is weighted by the proportions of traffic by road type (average congestion, noise, accidents MEC values (**Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 70:78)) x average proportions for total traffic **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 61:69). The figures are then interpolated for the years in between the five year intervals, using the five year interval values.

Box 9 Weighted average congestion, noise, accidents MEC

MEC values are imported from **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 70:78)

Average proportion for total traffic are imported from **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 61:69)

The weighted average congestion MEC is calculated in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 103:143).

	Unit	Year	London	London	London	Inner and Outer Conurbations	Inner and Outer Conurbations	Inner and Outer Conurbations	Other Urban	Other Urban	Rural	Rural	Rural
			Motorways	A Roads	Other Roads	Motorways	A Roads	Other Roads	A Roads	Other Roads	Motorways	A Roads	Other Roads
Weighted average congestion MEC	pence per veh km	2010	-	-	-	-	-	-	1.9	1.4	0.1	0.8	0.6
Weighted average congestion MEC	pence per veh km	2011	-	-	-	-	-	-	2.0	1.5	0.1	0.8	0.7
Weighted average congestion MEC	pence per veh km	2012	-	-	-	-	-	-	2.0	1.5	0.1	0.8	0.7
Weighted average congestion MEC	pence per veh km	2013	-	-	-	-	-	-	2.0	1.5	0.1	0.8	0.7
Weighted average congestion MEC	pence per veh km	2014	-	-	-	-	-	-	2.1	1.5	0.1	0.9	0.7
Weighted average congestion MEC	pence per veh km	2015	-	-	-	-	-	-	2.1	1.5	0.1	0.9	0.8
Weighted average congestion MEC	pence per veh km	2016	-	-	-	-	-	-	2.2	1.6	0.2	0.9	0.8
Weighted average congestion MEC	pence per veh km	2017	-	-	-	-	-	-	2.3	1.6	0.2	1.0	0.8
Weighted average congestion MEC	pence per veh km	2018	-	-	-	-	-	-	2.4	1.7	0.2	1.0	0.9
Weighted average congestion MEC	pence per veh km	2019	-	-	-	-	-	-	2.5	1.7	0.2	1.1	0.9
Weighted average congestion MEC	pence per veh km	2020	-	-	-	-	-	-	2.7	1.8	0.2	1.1	1.0
Weighted average congestion MEC	pence per veh km	2021	-	-	-	-	-	-	2.8	1.9	0.3	1.2	1.0
Weighted average congestion MEC	pence per veh km	2022	-	-	-	-	-	-	2.9	1.9	0.3	1.3	1.1
Weighted average congestion MEC	pence per veh km	2023	-	-	-	-	-	-	3.1	2.0	0.4	1.3	1.2
Weighted average congestion MEC	pence per veh km	2024	-	-	-	-	-	-	3.2	2.1	0.4	1.4	1.3
Weighted average congestion MEC	pence per veh km	2025	-	-	-	-	-	-	3.3	2.1	0.5	1.4	1.3
Weighted average congestion MEC	pence per veh km	2026	-	-	-	-	-	-	3.5	2.2	0.5	1.5	1.4
Weighted average congestion MEC	pence per veh km	2027	-	-	-	-	-	-	3.6	2.2	0.6	1.6	1.5
Weighted average congestion MEC	pence per veh km	2028	-	-	-	-	-	-	3.8	2.3	0.7	1.7	1.5
Weighted average congestion MEC	pence per veh km	2029	-	-	-	-	-	-	3.9	2.4	0.7	1.7	1.6
Weighted average congestion MEC	pence per veh km	2030	-	-	-	-	-	-	4.0	2.4	0.8	1.8	1.7
Weighted average congestion MEC	pence per veh km	2031	-	-	-	-	-	-	4.2	2.5	0.9	1.9	1.7
Weighted average congestion MEC	pence per veh km	2032	-	-	-	-	-	-	4.4	2.6	1.0	2.0	1.8
Weighted average congestion MEC	pence per veh km	2033	-	-	-	-	-	-	4.6	2.6	1.1	2.1	1.8
Weighted average congestion MEC	pence per veh km	2034	-	-	-	-	-	-	4.7	2.7	1.2	2.2	1.9
Weighted average congestion MEC	pence per veh km	2035	-	-	-	-	-	-	4.9	2.8	1.3	2.3	2.0

These data are carried forward into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 167:207; rows 211:251; rows 255:295) for the selected assessment period duration.

- Step 2: Discount costs over the appraisal period

In that step the cost per vehicle kilometre for each road type is multiplied by the number of vehicle km removed in each year of the appraisal period. In case inputs for individual years are not available, data for each year is interpolated from the five years interval values. Undiscounted congestion, noise and accident impact (as appropriate) is calculated by multiplying congestion data by veh km per year. Discounted congestion is then calculated by multiplying discount factor by undiscounted congestion per year.

Box 10 Discount costs over the appraisal period

This step of the calculations uses data on the change in vehicle kilometres (from **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 9:54) and the data on the weighted average congestion MEC (from **Calculations-Congestion** rows 103:143). Calculations are undertaken with an intermediate step of calculating Undiscounted congestion cost.

The Undiscounted congestion costs are calculated for each uncertainty level in separate tables:

- Uncertainty: low - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 167:207
- Uncertainty: high - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 211:251
- Uncertainty: central - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 255:295

An INDEX-MATCH-MATCH function is used for each of the 5 interval years (2010, 2015, 2020 etc.) to feed in the correct data on the change in vehicle kilometres from the “Change in vehicle kilometres” table (**Calculations-Congestion, Calculations-Noise, Calculations-Accidents**, rows 9:54). The first MATCH functions is used to select the data for the right row (year) in the reference lookup table (**Calculations-Congestion, Calculations-Noise, Calculations-Accidents** cells B9:B54) while the second MATCH function is used to define which column should be used for the calculation depending on the level of uncertainty specified in columns C:E. For the years between the 5 year intervals, if no direct inputs are available these are interpolated.

Box 10 Discount costs over the appraisal period

The vehicle kilometres are then multiplied by the relevant Weighted Average Congestion (Noise and Safety respectively for the impacts) MEC (**Calculations-Congestion, Calculations-Noise, Calculations-Accidents**, rows 103:143). For the years between the 5 year intervals, if there is specific user inputs for any given year, these will be used. If not the results are interpolated.

A discount factor is calculated in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** row 298 for each year of the assessment. The reference year is picked up from the **Control** (cell C12). The years for which discount factors are calculated are presented in **Calculations-Congestion** (row 267). The multiple IF functions are used to calculate the correct discount factor for the year in row 260. For the reference year and all years before the reference year, the discount factor is 1. For the years beyond the reference rate, the discount factor is calculated according to the equation presented in Box 3 above, using the discount rate in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (cell C159, which is fed from **Control**, cell C35).

The discounted congestion, noise, accidents costs are calculated separately for each uncertainty level:

- Uncertainty: low - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 302:342
- Uncertainty: high - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 346:386
- Uncertainty: central - **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 390:430

An INDEX MATCH function is used to pick up appropriate discount factor from **Calculations-Congestion, Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (row 298) for each year. The discount factor is then multiplied by the undiscounted congestion cost calculated for each uncertainty level in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** rows 167:207, 211:251, and 255:295.

The outputs of this calculation are the discounted costs for each year of the appraisal period for each uncertainty scenario. These feed into **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 446:448).

4.4 Results-congestion, results-noise, results-accidents and results-summary

The assessment provides the following outputs (in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 434:500).

- Discounted (present value) congestion, noise, accidents cost in target year prices

Box 11 Discounted (present value) congestion, noise, accidents cost in target year prices

The final output is presented in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 446:448).

For each uncertainty scenario, the total discounted congestion costs is fed from **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (column R) by using a SUMIF function. The total discounted congestion, noise, accidents costs are then adjusted for inflation (see information in Box 2).

Final impact output

Description: Discounted (present value) congestion cost in target year prices

Units: £k (2014 prices)

Inflation:

Input	Year	Value	Uncertainty score
GDP deflator (2013 = 100)	2010	94.677	2
GDP deflator (2013 = 100)	2014	89.46	

Final output:

Discounted (Present Value) cost	2010	2011	2012	2013
Low	-	0.12	0.24	0.37
High	-	0.07	0.14	0.21
Central	-	0.04	0.08	0.12

Output qualitative uncertainty score: 18 still need to run scenarios to get unce

The GDP deflators used for the inflation adjustment are presented in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (E441:E442) for:

- The year to which the costs / benefits should be inflated / deflated (see cell E84 feeding from **Control**, cell C15)
- The reference year in which MEC costs are presented (see cell E83 feeding from **Inputs-traffic,** cell C133)

The final output shown in **Calculations-Congestion, Calculations-Noise, Calculations-Accidents** (rows 446:448) feeds in to the **Results-Congestion, Results-Noise, Results-Accidents** and **Results-Summary** sheets

- Proportional change in vehicle km

Box 12 **This additional output presents the number of vehicle kilometres changed for each road type for low, high and central uncertainty scenario. Proportional change in vehicle km**

Calculation uses a change in vehicle kilometres in **Calculations-Congestion** (rows 9:54) and the proportion of total traffic for different area types and road types shown in **Calculations-Congestion** (rows 61:69). The INDEX-MATCH-MATCH function is used to pick up the change in vehicle kilometres for each 5 year interval and the corresponding uncertainty scenario (as specified in columns C:E). Vehicle kilometre change is then multiplied by the respective proportion of total traffic for different areas and road types (from **Calculations-Congestion** (rows 61:69)). These are undertaken for each uncertainty scenario.

	Unit	Quantitative uncertainty	Year	London	London	London	Inner and Outer Conurbations	Inner and Outer Conurbations	Inner and Outer Conurbations	Other Urban	Other Urban	Rural	Rural	Rural
				Motorways	A Roads	Other Roads	Motorways	A Roads	Other Roads	A Roads	Other Roads	Motorways	A Roads	Other Roads
Weighted change in veh km	veh km	low	2010	-	-	-	-	-	-	-	-	-	-	-
Weighted change in veh km	veh km	high	2010	-	-	-	-	-	-	-	-	-	-	-
Weighted change in veh km	veh km	central	2010	-	-	-	-	-	-	-	-	-	-	-
Weighted change in veh km	veh km	low	2015	-	-	-	- 610	- 810	- 760	- 1,030	- 770	- 770	- 3,430	- 1,830
Weighted change in veh km	veh km	high	2015	-	-	-	- 1,830	- 2,430	- 2,280	- 3,090	- 2,310	- 2,310	- 10,290	- 5,490
Weighted change in veh km	veh km	central	2015	-	-	-	- 1,220	- 1,620	- 1,520	- 2,060	- 1,540	- 1,540	- 6,860	- 3,660
Weighted change in veh km	veh km	low	2020	-	-	-	- 1,220	- 1,620	- 1,520	- 2,040	- 1,520	- 1,540	- 6,900	- 3,660
Weighted change in veh km	veh km	high	2020	-	-	-	- 2,440	- 3,240	- 3,040	- 4,080	- 3,040	- 3,080	- 13,800	- 7,320
Weighted change in veh km	veh km	central	2020	-	-	-	- 1,830	- 2,430	- 2,280	- 3,060	- 2,280	- 2,310	- 10,350	- 5,490
Weighted change in veh km	veh km	low	2025	-	-	-	- 1,240	- 1,620	- 1,500	- 2,020	- 1,500	- 1,620	- 6,840	- 3,640
Weighted change in veh km	veh km	high	2025	-	-	-	- 4,340	- 5,670	- 5,250	- 7,070	- 5,250	- 5,670	- 23,940	- 12,740
Weighted change in veh km	veh km	central	2025	-	-	-	- 3,100	- 4,050	- 3,750	- 5,050	- 3,750	- 4,050	- 17,100	- 9,100
Weighted change in veh km	veh km	low	2030	-	-	-	- 18,600	- 24,300	- 22,800	- 30,300	- 22,200	- 24,300	- 102,900	- 54,600
Weighted change in veh km	veh km	high	2030	-	-	-	- 37,200	- 48,600	- 45,600	- 60,600	- 44,400	- 48,600	- 205,800	- 109,200
Weighted change in veh km	veh km	central	2030	-	-	-	- 22,320	- 29,160	- 27,360	- 36,360	- 26,640	- 29,160	- 123,480	- 65,520
Weighted change in veh km	veh km	low	2035	-	-	-	- 15,500	- 20,250	- 19,000	- 25,000	- 18,500	- 20,250	- 85,750	- 45,750
Weighted change in veh km	veh km	high	2035	-	-	-	- 31,000	- 40,500	- 38,000	- 50,000	- 37,000	- 40,500	- 171,500	- 91,500
Weighted change in veh km	veh km	central	2035	-	-	-	- 18,600	- 24,300	- 22,800	- 30,000	- 22,200	- 24,300	- 102,900	- 54,900

This additional output is the same for all traffic related impacts and has therefore been calculated only once in **Calculations-Congestion** (rows 472:498). It is not presented in any of the results worksheets.

The information from the calculation sheets are fed into the **Results-Congestion, Results-Noise, Results-Accidents** and **Results-Summary** sheets.

Box 13 **Results-Congestion, Results- Noise, Results-Accidents and Results- Summary**

Results for the assessment of impacts on congestion, noise and accidents are presented in **Results-Congestion**, **Results-Noise** and **Results-Accidents** respecitvely. The three results sheets have the same structure. Figure below presents example of congestion.

The resutls are aggregated impacts to businesses, regulator and society as the assessment methodology does not allow distiguishing between the parties affected. Results are presented for each uncertianty scenario, and divided into costs (positive values) and benefits (negative values). Overall uncertainty score for the assessment is presented in cell D23.

Combined impact (aggregation of impacts to businesses, regulator and society/individual)

This category is used when the impact cannot be directly associated with one single group.

Units: £'000s			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Costs	Transition cost	Central																
		Low																
		High																
	Annual cost	Central	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
		Low	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
		High	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Benefits	Transition benefit	Central																
		Low																
		High																
	Annual benefit	Central	No data	No data	No data	No data	No data	-3.07	-3.64	-4.17	-4.65	-5.10	-5.52	-13.69	-21.30	-28.39	-34.97	-41.07
		Low	No data	No data	No data	No data	No data	-2.05	-2.09	-2.13	-2.16	-2.18	-2.21	-9.56	-16.41	-22.79	-28.72	-34.23
		High	No data	No data	No data	No data	No data	-4.09	-4.94	-5.72	-6.44	-7.11	-7.72	-21.68	-34.68	-46.78	-58.02	-68.45

The results of the assessment of impacts on congestion, noise and accidents are summarised in the **Results- Summary** sheet in rows 15:23 for Congestion, rows 26:34 for Noise, rows 37:45 for Accidents. These presents total costs and benefits of the measure over the appraisal period and the Net Present Value of the intervention.

Congestion

npv	Costs									Benefits									Total Net Present Value		
2014 prices	Total Transition			Average Annual			Total annualised costs			Transition benefit			Annual benefit			Total annualised benefits					
£'000s	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High
Impact to business																					
Impact to regulator																					
Impact to society																					
Total impact				-	-	-	-	-	-				- 166	- 125	- 266	- 166	- 125	- 266	-165.6	-125	-266

4.5 Limitations

General points

- MEC impacts can be currently used to assess impacts up to 2035. This is because fixed inputs from WebTAG are only available up to this date. When building the tool it was anticipated future updates will include further years. In that case, additional fixed inputs and user inputs can be added in the available empty spaces.
- The MEC method does not take into account all of the responses available to those who switch mode (for example those changing destinations) or the effect of the initial change in traffic levels on costs and subsequent demand.
- The method described above assumes that the alternative journeys taken in the without scheme and with scheme scenarios have the same origin and destination area types. This simplifying assumption is necessary in the absence of a trip distribution mode.
- No significant adjustments needed to be made in order to build the WebTAG A5.4 MEC approach into the tool. However, updates to future versions of the relevant parameters (which are typically released annually) will be facilitated through links to relevant cells in the new and convenient TAG data book Excel spreadsheet.
- The results are provided directly in monetised terms discounted over the appraisal. The limitations of the approach are that (unless vehicle km changes are provided to the same level of detail as the WebTAG traffic data) pro rata effects of vehicle km change by road type must be assumed. Furthermore, this approach cannot match the detailed localised accuracy of full transport modelling, but detailed modelling would greatly extend the scope and complexity of the wider impacts model.
- During the impact identification and screening, traffic and vehicle speeds as well as travelling time were considered as separate, but correlated, impacts to the congestion impact. Traffic/vehicle speed changes are the result of the change in vehicle km due to the potential air quality measures affecting highway congestion levels. The speeds themselves are not directly monetised but the resulting travel time changes can be. However, these speed changes and resulting travel time changes are precisely the impacts which have already been monetised through the MEC method for congestion impacts assessment, so attempting to monetise them again would result in double counting. Therefore, both of these impacts should be considered as already accounted for and monetised by the MEC Congestion Impact indicator and are not proposed to be assessed separately.

Congestion impact

- When the above method is applied then both the direct estimation of congestion levels from assessment of the difference between free-flow (i.e. uncongested) vehicle hours and congested vehicle hours using outputs from a detailed local highway traffic assignment model (including the effects of blocking back and interacting traffic flows at junctions), and use of approximate elasticity-based techniques to estimate changes in congestion from given input changes in vehicle km, are accounted for.

Safety/ accidents impact

- When the above method is applied then both link and junction accident rate analysis using outputs from a network-based local highway traffic assignment model, and third party accident rate estimation tools, are accounted for.

Noise impact

- When the above method is applied then detailed exposure level assessment using outputs from a network-based local highway traffic assignment model, and an estimation of population density within different distance bands of highway links, are accounted for.

5. Method to assess impacts of modal shift

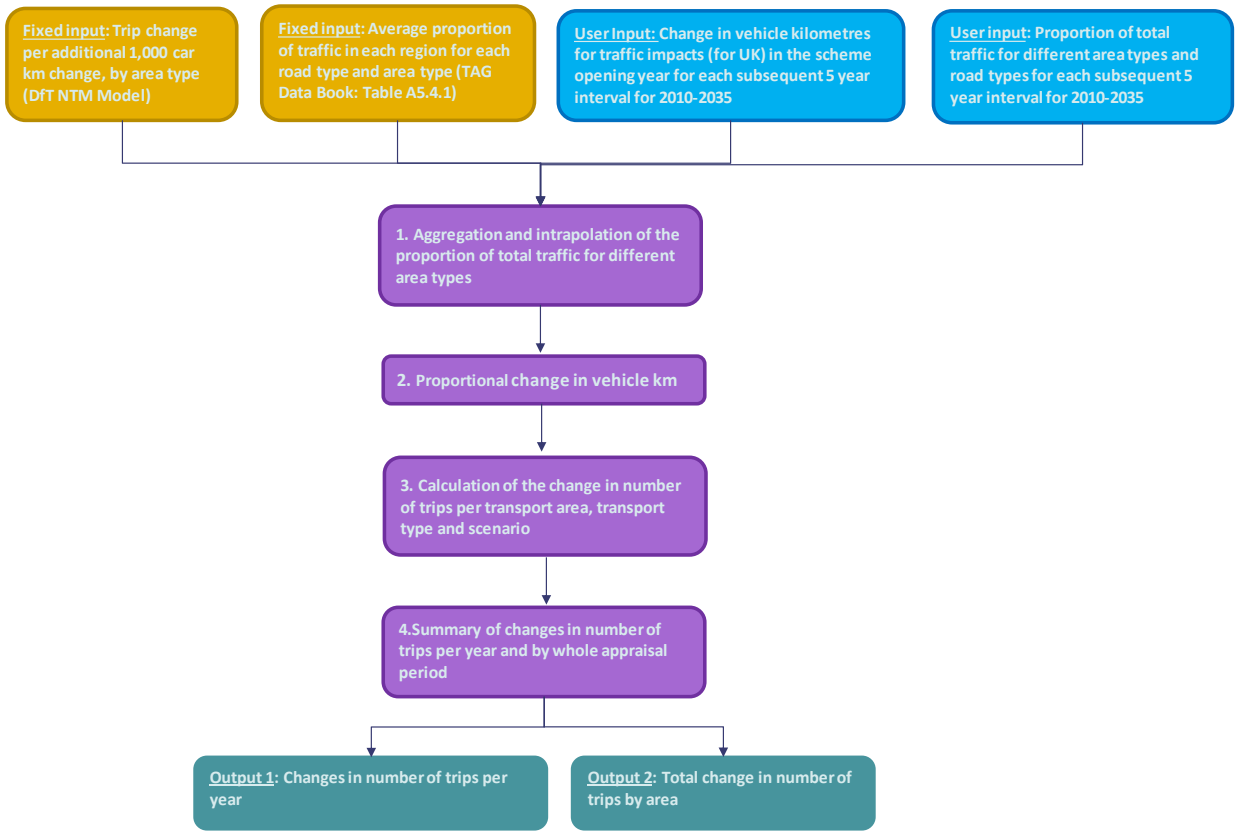
Overview

Traffic is a major source of air pollution; therefore the most effective way to reduce air pollution is to remove traffic from the road network. Policies that reduce highway traffic vehicle kilometres will, with all other things being equal, proportionately reduce polluting emissions and concentrations. Conversely, policies that increase vehicle kilometres will, with all other things being equal, lead to proportionately increased emissions.

A modal shift occurs when one mode (e.g. bus) has a comparative advantage (including costs, flexibility, capacity etc.) in a similar market over another (e.g. car). Comparative advantages can take various forms, such as costs, capacity, time, flexibility or reliability[6]. Specifically, a mode shift from car to active transport modes (cycling and walking) can provide benefits in terms of personal health, welfare costs and climate change[7].

For the method for estimating model shift impacts, similarly with the Congestion impacts, the approach refers from the WebTAG unit A5.4 which uses the TAG Data book (from May 2014). The WebTAG A5.4 MEC method was selected as it is part of official UK Government (DfT) guidance, and is a proportionate approach suitable for the current tool. In addition to the MEC method, estimated trip changes from the DfT National Transport Model (NTM) was specifically utilised in the assessment of modal shift. Figure 5.1 outlines the process for the modal shift impact assessment.

Figure 5.1 Overview of the methodology to assess modal shift



[6] The Geography of Transport Systems, Dr. Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University, New York, USA
[7] Can a mode shift to walking and cycling benefit health and climate?, James Woodcock and Felix Creutzig, The European Dahrendorf Debate Symposium, 2013

5.1 Inputs

Inputs used to calculate the impacts of modal shift are summarised in Table 5.1below.

Table 5.1 Summary of inputs – modal shift

Input	Units	Comment	Source
User Inputs:			
Change in vehicle km	veh km	The user enters an estimate of the net change in vehicle kilometres due to the intervention for each 5 year interval for the assessment period.	Assessment of the measure
Proportion of total traffic for different area types and road types	Percentage per area and road type	This is determined by the extent to which vehicles are diverted off (or onto) different road and area types by the air quality policy. The user can enter the percentage distribution of traffic between each area and road type. If this detail for the location of the change in vehicle km is unknown the user can select the geographic region and average values for the region will be applied to allow for calculation of the impact of the net change in vehicle kms.	Assessment of the measure
Fixed Inputs:			
Average proportion of traffic in each region for each road type and area type	Percentage weightings of total traffic	The primary limitation is that lack of a highway model will result in using regional averages from the National Transport Model (NTM)	TAG Data Book –Table A5.4.1
Trip change per additional 1,000 car km change, by area type	No. of trips	Number of trips by car, walking, cycling, bus and rail per 1,000 car km	DfT NTM Model

The **user inputs** required to calculate the impact are:

- **Change in vehicle km**: Changes in number of vehicle kilometres can be direct impacts of air quality measures. These data have to be provided by the user of the model[8]. In the absence of local evidence, estimates of regional traffic flows derived from the NTM can be used.

[8] For short distance trips, the change in vehicle km data can be obtained by passenger surveys, whereas for long distance trips the data can be obtained from National Transport Statistics Database (TAG Unit A5.4 Marginal External Costs)

Box 14 Change in vehicle kilometres

Change in vehicle kilometres are to be entered by the user in **Control** "Table 1" (rows 41:91) along with the associated five year interval years. Central, low and high values can be entered and all are carried through into the calculations and presentation of the results.

Alternatively the user can select a qualitative uncertainty indicator, for which a numerical value is automatically assigned. The numerical value is carried through the calculations and results to be combined with the uncertainty score of other input parameters in order to provide an indication of the uncertainty level of the results.

Table 1 Change in vehicle kilometers for traffic impacts (for UK)

Year	Change in vehicle kilometers			Uncertainty		Comments	Reference
	Central	Low	High	Qualitative	Score		
	veh km	veh km	veh km				
2010	-	-	-	not used	1		
2015	7,000	4,000	12,000	not used	1		
2020	5,000	2,000	10,000	not used	1		
2025	-5,000	-2,000	-7,000	not used	1		
2030	-36,000	-30,000	-60,000	not used	1		
2035	-30,000	-25,000	-50,000	not used	1		

← Ungroup to expand more input rows

These data are carried forward into **Calculations-ModalShift,** (rows 5:15) for the selected assessment period duration.

Proportion of total traffic for different area types and road types: A shift in the location of vehicle kilometres between different area and road types can be a direct impact of an air quality measures. These data can be provided by the user of the model[9].

- However, if these data are not available the user can instead select the geographical region in which the change in vehicle km occur and default average distribution of traffic for that region is applied. This allows for an assessment of the net change in vehicle km but as the default values are a no measure counterfactual the impact of a shift between area and road type is not incorporated in the results.

[9] For short distance trips, the change in vehicle km data can be obtained by passenger surveys, whereas for long distance trips the data can be obtained from National Transport Statistics Database (TAG Unit A5.4 Marginal External Costs)

Box 15 Proportion of total traffic for different area types and road types

The distribution of the change in vehicle kilometres across different areas and road types can be entered by the user in **Control** "Table 2 (Optional)" (rows 99:104) along with the associated five year interval years. The numerical value is carried through the calculations and results to be combined with the uncertainty score of other input parameters in order to provide an indication of the uncertainty level of the results.

Table 2 (Optional) **Proportion of total traffic for different area types and road types** **Unit:** **% of total traffic**

If the user does not specify the proportion of total traffic for area and road types, standard values will apply according to the selected region.

Year	London Motorways	London A Roads	London Other Roads	Inner and Outer Conurbations Motorways	Inner and Outer Conurbations A Roads	Inner and Outer Conurbations Other Roads	Other Urban A Roads	Other Urban Other Roads
	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic	% of total traffic
2010								
2015								
2020								
2025								
2030								
2035								

← *Ungroup to expand more input rows*

Would be useful to include a check for totals to make sure these add to a 100%

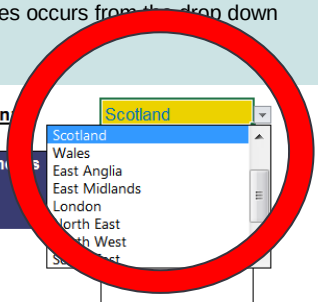
Rural Motorways	Rural A Roads	Rural Other Roads	Uncertainty Qualitative	Uncertainty Score
% of total traffic	% of total traffic	% of total traffic		
			medium	3
			medium	3
			medium	3
			medium	3
			medium	3
			medium	3

These data are carried forward into **Calculations-ModalShift** (rows 21:29) for the selected assessment period duration.

Alternatively the user can select the geographical region in which the change in vehicle kilometres occurs from the drop down menu (cell I41) in Control "Table 1" (row 41).

43 **Change in vehicle kilometers for traffic impacts (for UK)** **Region**

	Change in vehicle kilometers Central	Low	High	Uncertainty Qualitative	Uncertainty Score
46					
47	veh km	veh km	veh km		
48	-	-	-	not used	1
49	- 20,000	- 10,000	- 30,000	not used	1
50	- 30,000	- 20,000	- 40,000	not used	1
51	- 50,000	- 20,000	- 70,000	not used	1
52	- 360,000	- 300,000	- 600,000	not used	1
53	- 300,000	- 250,000	- 500,000	not used	1



To change the options in the drop down menu, select the cell and click on "Data Validation" in the Data ribbon. In the Data Validation pop-up window, in the field "Source", the user can see the reference range for the list of regions (**Control,** cells L44:L56:). To update the list of regions, type in the new region names in the reference cells. If the new list is longer, please update the reference range in the "Source" box as required, then click on "OK".

This data is carried forward into **Calculations- ModalShift** (cell H5). The traffic data relevant for the selected region are then populated in **Calculations- ModalShift** (rows 21:29).

The categories for the area and road type, and the list of geographic regions, are compatible with the fixed inputs (described below) and therefore should only be changed if the format of the fixed inputs is changed.

The **fixed inputs** required to calculate the impact are:

- **Average proportion of total traffic for different area types and road types:** The proportions of traffic for each road type and area type vary by region and are given in Table A5.4.1, TAG Data Book. Proportions of traffic are given for 2010 and five year intervals to 2035.

Box 16 Proportion of total traffic

Average traffic proportions are presented in **Inputs-traffic** (rows 8:109). Separate tables are provided for each five year interval from 2010 to 2050. The categories and format is consistent with WebTAG Table A 5.4.1, from which data for 2010-2035 has been extracted (2040-2050 data are not yet available but the tables for these years have been included for when this data is available).

Proportion of total traffic for different area types and road types

		2010 London Mo	2010 London A	2010 London Oth	2010 Inner and	2010 Inner and	2010 Inner and	2010 Other Urba	2010 Other Urba	2010 Rural Moto	2010 Rural A Ro	2010 Rural Other Roads	
		2010 Proportion of Total Traffic in each congestion band for different regions, area types and road types (1 d.p.)											
Region	Congestion band	London Motorways	London A Roads	London Other Roads	Inner and Outer Motorways	Inner and Outer A Roads	Inner and Outer Other Roads	Other Urban A Roads	Other Urban Other Roads	Rural Motorways	Rural A Roads	Rural Other Roads	Grand Total
	1	0.1%	0.3%	1.1%	0.7%	1.2%	3.9%	2.2%	8.1%	2.8%	11.4%	11.3%	**43.0%**
	2	0.2%	0.8%	0.7%	1.8%	2.2%	1.6%	4.4%	2.8%	6.5%	9.0%	1.7%	**31.6%**
	3	0.0%	1.0%	0.3%	1.7%	1.5%	0.8%	3.3%	1.1%	4.1%	2.2%	0.5%	**16.6%**
	4	0.0%	1.0%	0.3%	0.5%	1.2%	0.7%	1.9%	0.5%	0.6%	0.5%	0.3%	**7.5%**
	5	0.0%	0.3%	0.1%	0.0%	0.1%	0.1%	0.4%	0.0%	0.0%	0.0%	0.2%	**1.2%**
Great Britain	**Average**	**0.3%**	**3.5%**	**2.5%**	**4.6%**	**6.2%**	**7.1%**	**12.3%**	**12.5%**	**14.0%**	**23.1%**	**14.0%**	**100.0%**

Although the geographical scope for the Wider Impacts model is the whole of the UK, the best available information in WebTAG is for Great Britain. It is recommended to use Great Britain for general cases. Data for lower level geographical regions is included in the model should the user have information on the region in which the intervention occurs.

If the user is not able to provide this distribution of the net change in vehicle kilometres then the relevant region can be selected and default values applied. As these default values are based on the counterfactual this does not allow for assessment of the impact of change in location of vehicle kms – it only allows for assessment of the impact of the net total change in vehicle kms. When applied, these data are carried forward into **Calculations- ModalShift** (rows 21:29) for the selected assessment period duration.

- **Trip change per additional 1,000 car km change, by area type:** The number of trips for car, walking, cycling, bus and rail per additional 1,000 car km change. Information provided for each area type: London, inner and outer conurbations, other urban, rural and Great Britain as a whole. These factors were derived from the responses of the National Transport Model (NTM) to change in fuel cost (affecting car only) in a 2020 forecast year and the average response from tests on increasing and decreasing fuel cost was used. The tests caused changes in both mode and destination choice for all trip purposes originating in the given area type. For each 1,000 car km change in such trips, the numbers of trips changed were calculated. The greatest mode shift impact in the model was an increase in car occupancy (switch to car passenger from car driver) over changes to other modes.

Box 17 Trip change per additional 1,000 car km change, by area type

Number of trips per car, walking, cycling, bus and rail by area type are presented in **Inputs-traffic** (rows 144:161).

Trip change per additional 1,000 car km change, by area type

Area type	Car	Walk	Cycle	Bus	Rail	Total
London	4.8	-0.8	-0.2	-1.7	-2.1	0.0
Inner and Outer Conurbations	7.8	-2.8	-0.7	-3.0	-1.3	0.0
Other Urban	9.1	-3.7	-0.7	-3.4	-1.3	0.0
Rural	9.1	-4.4	-0.8	-3.5	-0.4	0.0
Great Britain	8.3	-3.4	-0.7	-3.1	-1.2	0.0

When applied, these data are carried forward into **Calculations- ModalShift** (rows 34:38) for the selected assessment period duration.

5.2 Calculations

Calculations are undertaken in the following worksheets: **Calculations-ModalShift.** The assessment method is comprised of the following steps:

- Step 1: Aggregation and intrapolation of the proportion of total traffic for different area types

In that step, the different road types (i.e. Motorways, A Roads and Other Roads) are aggregated for the proportion of total traffic for different area types (geographical regions in UK) and road types (**Calculations-ModalShift** (row 21-29)). The figures are then interpolated for the years between the five year intervals, using the five year interval values.

Box 18 Aggregation and intrapolation of the proportion of total traffic for different area types

Proportion of total traffic for different area types and road type's values are imported from **Calculations-ModalShift** (row 21-29).

These data are carried forward into the different scenarios for **Calculations- ModalShift** Step 2: Proportion change in vehicle kilometres.

The table for the aggregation and interpolation of the proportion of total traffic for different area types are set out in **Calculations-ModalShift** rows 55-95.

	Unit	Year	London	Inner and Outer Conurbations	Other Urban	Rural	Total
Intrapolated proportion of total traffic for different area types	% of total traffic	2010	0.0%	21.6%	17.8%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2011	0.0%	21.6%	17.8%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2012	0.0%	21.7%	17.9%	60.4%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2013	0.0%	21.7%	17.9%	60.4%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2014	0.0%	21.8%	18.0%	60.3%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2015	0.0%	21.8%	18.0%	60.3%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2016	0.0%	21.8%	18.0%	60.3%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2017	0.0%	21.8%	17.9%	60.4%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2018	0.0%	21.8%	17.9%	60.4%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2019	0.0%	21.8%	17.8%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2020	0.0%	21.8%	17.8%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2021	0.0%	21.8%	17.8%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2022	0.0%	21.8%	17.7%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2023	0.0%	21.8%	17.7%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2024	0.0%	21.8%	17.6%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2025	0.0%	21.8%	17.6%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2026	0.0%	21.8%	17.6%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2027	0.0%	21.8%	17.6%	60.5%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2028	0.0%	21.9%	17.5%	60.6%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2029	0.0%	21.9%	17.5%	60.6%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2030	0.0%	21.9%	17.5%	60.6%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2031	0.0%	21.9%	17.5%	60.6%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2032	0.0%	21.9%	17.5%	60.6%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2033	0.0%	21.9%	17.4%	60.7%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2034	0.0%	21.9%	17.4%	60.7%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2035	0.0%	21.9%	17.4%	60.7%	100%
Intrapolated proportion of total traffic for different area types	% of total traffic	2036	0.0%	17.5%	13.9%	48.6%	80%
Intrapolated proportion of total traffic for different area types	% of total traffic	2037	0.0%	13.1%	10.4%	36.4%	60%

- Step 2: Proportional change in vehicle km

For this step, the proportional change is calculated by the weighted change in vehicle kilometres for each area and scenario. If no data is available for any given year, the figure will interpolate from the five year interval.

Box 19 Proportional change in vehicle km

The calculation of proportional change in vehicle km are imported from the following sheet:

- **Calculations- ModalShift** Step 2: Proportion change in vehicle kilometres
  - rows 112:152 for low scenario
  - rows 156:196 for high scenario
  - rows 200:240 for central scenario
- **Calculations- ModalShift** (row 34:38) for Trip change per additional 1,000 car km change, by area type

These data are carried forward into the different scenarios for **Calculations- ModalShift** (Rows 111:240) Step 3 Calculation of the change in number of trips per transport area and transport type.

	Unit	Quantitative uncertainty	Year	London	Inner and Outer Conurbations	Other Urban	Rural
Proportional change in veh km	veh km	low	2010	0	0	0	0
Proportional change in veh km	veh km	low	2011	0	-436	-360	-1206
Proportional change in veh km	veh km	low	2012	0	-872	-720	-2412
Proportional change in veh km	veh km	low	2013	0	-1308	-1080	-3618
Proportional change in veh km	veh km	low	2014	0	-1744	-1440	-4824
Proportional change in veh km	veh km	low	2015	0	-2180	-1800	-6030
Proportional change in veh km	veh km	low	2016	0	-2616	-2152	-7244
Proportional change in veh km	veh km	low	2017	0	-3052	-2504	-8458
Proportional change in veh km	veh km	low	2018	0	-3488	-2856	-9672
Proportional change in veh km	veh km	low	2019	0	-3924	-3208	-10886
Proportional change in veh km	veh km	low	2020	0	-4360	-3560	-12100
Proportional change in veh km	veh km	low	2021	0	-4360	-3552	-12100
Proportional change in veh km	veh km	low	2022	0	-4360	-3544	-12100
Proportional change in veh km	veh km	low	2023	0	-4360	-3536	-12100
Proportional change in veh km	veh km	low	2024	0	-4360	-3528	-12100
Proportional change in veh km	veh km	low	2025	0	-4360	-3520	-12100
Proportional change in veh km	veh km	low	2026	0	-16628	-13316	-46040
Proportional change in veh km	veh km	low	2027	0	-28896	-23112	-79980
Proportional change in veh km	veh km	low	2028	0	-41164	-32908	-113920
Proportional change in veh km	veh km	low	2029	0	-53432	-42704	-147860
Proportional change in veh km	veh km	low	2030	0	-65700	-52500	-181800
Proportional change in veh km	veh km	low	2031	0	-63510	-50700	-175790
Proportional change in veh km	veh km	low	2032	0	-61320	-48900	-169780
Proportional change in veh km	veh km	low	2033	0	-59130	-47100	-163770
Proportional change in veh km	veh km	low	2034	0	-56940	-45300	-157760
Proportional change in veh km	veh km	low	2035	0	-54750	-43500	-151750
Proportional change in veh km	veh km	low	2036	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Proportional change in veh km	veh km	low	2037	Insufficient data	Insufficient data	Insufficient data	Insufficient data

- Step 3: Calculation of the change in number of trips per transport area, transport type and scenario

To calculate the change in number of trips for each transport area, type and scenarios (i.e. central, low and high), the distributed change in car kilometres travelled is multiplied by the relevant factor (number of trips per 100 car km change) for each transport mode and area.

Box 20 Calculation of the change in number of trips per transport area, transport type and scenario

The calculation of change in number of trips per transport area, transport type and scenario are imported from the following sheet:

- **Calculations- ModalShift** Step 2: Proportion change in vehicle
  - rows 112:152 for low scenario
  - rows 156:196 for high scenario
  - rows 200:240 for central scenario
- **Calculations- ModalShift** (rows 34:38) for Trip change per additional 1,000 car km change, by area type
- **Calculations- ModalShift** (rows 9:15) for Change in vehicle kilometres

The table for the calculation of the change in number of trips per transport area, transport type and scenario are set out in **Calculations-ModalShift** rows 259:389:

- Rows 259:299 for low scenario
- Rows 303:343 for high scenario
- Rows 347:387 for central scenario

	Unit	Quantitative uncertainty	Year	London	London	London	London	London	Inner and Outer Conurbations	Inner and Outer Conurbations
				Car	Walk	Cycle	Bus	Rail	Car	Walk
Change in number of trips per area and vehicle type	Number of trips	low	2010	-	-	-	-	-	-	-
Change in number of trips per area and vehicle type	Number of trips	low	2011	-	-	-	-	-	- 3.42	1.24
Change in number of trips per area and vehicle type	Number of trips	low	2012	-	-	-	-	-	- 6.83	2.47
Change in number of trips per area and vehicle type	Number of trips	low	2013	-	-	-	-	-	- 10.25	3.71
Change in number of trips per area and vehicle type	Number of trips	low	2014	-	-	-	-	-	- 13.67	4.95
Change in number of trips per area and vehicle type	Number of trips	low	2015	-	-	-	-	-	- 17.08	6.19
Change in number of trips per area and vehicle type	Number of trips	low	2016	-	-	-	-	-	- 20.50	7.42
Change in number of trips per area and vehicle type	Number of trips	low	2017	-	-	-	-	-	- 23.92	8.66
Change in number of trips per area and vehicle type	Number of trips	low	2018	-	-	-	-	-	- 27.34	9.90
Change in number of trips per area and vehicle type	Number of trips	low	2019	-	-	-	-	-	- 30.75	11.14
Change in number of trips per area and vehicle type	Number of trips	low	2020	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2021	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2022	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2023	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2024	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2025	-	-	-	-	-	- 34.17	12.37
Change in number of trips per area and vehicle type	Number of trips	low	2026	-	-	-	-	-	- 130.32	47.19
Change in number of trips per area and vehicle type	Number of trips	low	2027	-	-	-	-	-	- 226.46	82.01
Change in number of trips per area and vehicle type	Number of trips	low	2028	-	-	-	-	-	- 322.61	116.83
Change in number of trips per area and vehicle type	Number of trips	low	2029	-	-	-	-	-	- 418.75	151.64

(table continued)

Inner and Outer Conurbations	Inner and Outer Conurbations	Inner and Outer Conurbations	Other Urban	Other Urban	Other Urban	Other Urban	Other Urban	Rural	Rural	Rural	Rural	Rural	Total change in trips	Total change in trips	Total change in trips	Total change in trips	Total change in trips	Total change in trips
Cycle	Bus	Rail	Car	Walk	Cycle	Bus	Rail	Car	Walk	Cycle	Bus	Rail	Car	Walk	Cycle	Bus	Rail	Total
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.29	1.32	0.58	- 3.29	1.34	0.26	1.22	0.47	- 11.02	5.27	1.01	4.26	0.50	- 17.73	7.84	1.56	6.79	1.55	0
0.57	2.63	1.15	- 6.59	2.68	0.53	2.43	0.95	- 22.04	10.53	2.02	8.51	0.99	- 35.46	15.69	3.11	13.58	3.09	0
0.86	3.95	1.73	- 9.88	4.02	0.79	3.65	1.42	- 33.06	15.80	3.02	12.77	1.49	- 53.19	23.53	4.67	20.37	4.64	0
1.14	5.27	2.31	- 13.17	5.36	1.05	4.87	1.90	- 44.08	21.07	4.03	17.03	1.98	- 70.92	31.38	6.22	27.16	6.19	0
1.43	6.58	2.88	- 16.46	6.70	1.31	6.09	2.37	- 55.10	26.34	5.04	21.29	2.48	- 88.65	39.22	7.78	33.95	7.74	0
1.71	7.90	3.46	- 19.68	8.01	1.57	7.28	2.83	- 66.19	31.64	6.05	25.57	2.98	- 106.38	47.07	9.34	40.75	9.28	0
2.00	9.22	4.04	- 22.90	9.32	1.83	8.47	3.30	- 77.28	36.94	7.07	29.86	3.48	- 124.10	54.92	10.89	47.54	10.82	0
2.28	10.53	4.61	- 26.12	10.63	2.09	9.66	3.76	- 88.37	42.24	8.08	34.14	3.98	- 141.83	62.77	12.45	54.33	12.36	0
2.57	11.85	5.19	- 29.34	11.94	2.34	10.85	4.22	- 99.47	47.55	9.10	38.43	4.48	- 159.56	70.62	14.01	61.12	13.89	0
2.85	13.17	5.77	- 32.56	13.25	2.60	12.04	4.69	- 110.56	52.85	10.11	42.71	4.98	- 177.29	78.47	15.57	67.91	15.43	0
2.85	13.17	5.77	- 32.49	13.22	2.59	12.01	4.68	- 110.56	52.85	10.11	42.71	4.98	- 177.22	78.44	15.56	67.89	15.42	0
2.85	13.17	5.77	- 32.42	13.19	2.59	11.98	4.67	- 110.56	52.85	10.11	42.71	4.98	- 177.15	78.41	15.55	67.86	15.41	0
2.85	13.17	5.77	- 32.34	13.16	2.58	11.96	4.66	- 110.56	52.85	10.11	42.71	4.98	- 177.07	78.38	15.55	67.83	15.40	0
2.85	13.17	5.77	- 32.27	13.13	2.58	11.93	4.65	- 110.56	52.85	10.11	42.71	4.98	- 177.00	78.35	15.54	67.81	15.39	0
2.85	13.17	5.77	- 32.20	13.10	2.57	11.90	4.64	- 110.56	52.85	10.11	42.71	4.98	- 176.93	78.32	15.54	67.78	15.38	0
10.89	50.22	22.00	- 121.80	49.56	9.72	45.02	17.54	- 420.67	201.09	38.48	162.52	18.94	- 672.79	297.84	59.09	257.75	58.48	0
18.92	87.26	38.23	- 211.41	86.02	16.87	78.14	30.44	- 730.78	349.33	66.84	282.32	32.91	- 1,168.65	517.36	102.63	447.73	101.57	1
26.95	124.31	54.46	- 301.02	122.49	24.03	111.26	43.34	- 1,040.89	497.57	95.20	402.12	46.87	- 1,664.52	736.88	146.18	637.70	144.67	1
34.99	161.36	70.69	- 390.62	158.95	31.18	144.39	56.24	- 1,351.00	645.81	123.57	521.93	60.83	- 2,160.38	956.40	189.73	827.67	187.76	1

These data are carried forward into **Calculations- ModalShift** (rows 398:412) for each road type per scenario (i.e. central, low and high) and **Calculations- ModalShift** (rows 417:421) for each road and area types into in the selected assessment period duration.

5.3 Results-modal shift and results-summary

The calculation assessment in the section above provides the following outputs in **Calculations-ModalShift** (rows 391:424)):

- **Change in number of trips per year and total change in number of trips for the whole appraisal period**

Box 21 Change in number of trips per year and total change in number of trips for the whole appraisal period

The final output is presented in **Calculations- ModalShift** (rows 397:412) and **Calculations- ModalShift** (rows 416:421). These then feed directly to the **Result-Modal shift** rows 7:28 and 29:40.

Change in number of trips per year

For each uncertainty scenario (i.e. central, low and high) the change in number of trips per year is fed from:

- **Calculations- ModalShift** (rows 259:299) for low scenario
- **Calculations- ModalShift** (rows 303:343) for high scenario
- **Calculations- ModalShift** (rows 347:387) for central scenario

The area types are summed (columns G: Z) into total trips per year (column AB: AF) for each uncertainty scenario. Qualitative uncertainty score is shown in cell E26.

Change in number of trips per year		2010	2011	2012	2013	2014	2015	2016	2017
Car	Low	-	- 18	- 35	- 53	- 71	- 89	- 106	- 124
	High	-	- 53	- 106	- 160	- 213	- 266	- 284	- 301
	Central	-	- 35	- 71	- 106	- 142	- 177	- 195	- 213
Walk	Low	-	8	16	24	31	39	47	55
	High	-	24	47	71	94	118	126	133
	Central	-	16	31	47	63	78	86	94
Cycle	Low	-	2	3	5	6	8	9	11
	High	-	5	9	14	19	23	25	26
	Central	-	3	6	9	12	16	17	19
Bus	Low	-	7	14	20	27	34	41	48
	High	-	20	41	61	81	102	109	115
	Central	-	14	27	41	54	68	75	81
Rail	Low	-	2	3	5	6	8	9	11
	High	-	5	9	14	19	23	25	26
	Central	-	3	6	9	12	15	17	19

Total change in number of trips for the whole appraisal period

For each uncertainty scenario (i.e. central, low and high), the total change in number of trips by area over the whole appraisal period is fed from:

- **Calculations- ModalShift** (rows 259:299) for low scenario
- **Calculations- ModalShift** (rows 303:343) for high scenario
- **Calculations- ModalShift** (rows 347:387) for central scenario

This is done by using a SUMIF function and over the appraisal period set by input data fed from **Control** row C13 for measure start year and row C14 for assessment end year.

	Low				High				Central			
Total change in number of trips for the whole appraisal period	London	Inner and Outer Conurbations	Other Urban	Rural	London	Inner and Outer Conurbations	Other Urban	Rural	London	Inner and Outer Conurbations	Other Urban	Rural
Car	-	- 1,818	- 1,699	- 5,868	-	- 3,892	- 3,640	- 12,565	-	- 2,435	- 2,278	- 7,860
Walk	-	658	691	2,805	-	1,410	1,481	6,006	-	882	927	3,757
Cycle	-	152	136	537	-	325	291	1,149	-	203	182	719
Bus	-	701	628	2,267	-	1,500	1,346	4,854	-	938	842	3,036
Rail	-	307	245	264	-	657	524	566	-	411	328	354

The final output shown in **Calculations- ModalShift** (rows 397:412) and **Calculations- ModalShift** (rows 416:421) feeds into the **Results-Modal shift** into following tables: Change in the number of trips per year in **Results-Modal shift** (rows 7:26) and Total change in number of trips for the whole appraisal period in **Results-Modal shift** (rows 29:40)

Box 21 **Change in number of trips per year and total change in number of trips for the whole appraisal period**

Change in number of trips per year

Unit:	Number of trips		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Car	Central						-265.94	-301.21	-336.49	-371.76	-407.04	-442.32
		Low						-177.29	-177.22	-177.15	-177.07	-177.00	-176.93
		High						-354.58	-407.52	-460.45	-513.38	-566.31	-619.24
	Walk	Central						117.71	133.33	148.95	164.57	180.19	195.81
		Low						78.47	78.44	78.41	78.38	78.35	78.32
		High						156.95	180.39	203.82	227.26	250.70	274.14
	Cycle	Central						23.35	26.45	29.55	32.64	35.74	38.84
		Low						15.57	15.56	15.55	15.55	15.54	15.54
		High						31.13	35.78	40.43	45.08	49.73	54.38
	Bus	Central						101.87	115.39	128.90	142.42	155.93	169.45
		Low						67.91	67.89	67.86	67.83	67.81	67.78
		High						135.83	156.11	176.39	196.67	216.95	237.23
	Rail	Central						23.15	26.21	29.27	32.33	35.39	38.46
		Low						15.43	15.42	15.41	15.40	15.39	15.38
		High						30.87	35.46	40.06	44.65	49.24	53.84

Results qualitative uncertainty score:	9

Total change in number of trips for the whole appraisal period

	Low				High				Central			
	London	Inner and Outer Conurbations	Other Urban	Rural	London	Inner and Outer Conurbations	Other Urban	Rural	London	Inner and Outer Conurbations	Other Urban	Rural
Car	-	- 1,818	- 1,699	- 5,868	-	- 3,892	- 3,640	- 12,565	-	- 2,435	- 2,278	- 7,860
Walk	-	658	691	2,805	-	1,410	1,481	6,006	-	882	927	3,757
Cycle	-	152	136	537	-	325	291	1,149	-	203	182	719
Bus	-	701	628	2,267	-	1,500	1,346	4,854	-	938	842	3,036
Rail	-	307	245	264	-	657	524	566	-	411	328	354

Results qualitative uncertainty score:	9

Box 22 **Results-Summary for Modal shift**

Summary results for modal shift assessment are presented in **Results-Summary** rows 48:56. These provide total number of trips diverted from car to other transport modes over the whole appraisal period.

Modal shift

Total change in number of trips for the whole appraisal period	London			Inner and Outer Conurbations			Other Urban			Rural		
	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High
Car	-	-	-	- 2,435	- 1,818	- 3,892	- 2,278	- 1,699	- 3,640	- 7,860	- 5,868	- 12,565
Walk	-	-	-	882	658	1,410	927	691	1,481	3,757	2,805	6,006
Cycle	-	-	-	203	152	325	182	136	291	719	537	1,149
Bus	-	-	-	938	701	1,500	842	628	1,346	3,036	2,267	4,854
Rail	-	-	-	411	307	657	328	245	524	354	264	566

The high–level summary results for this impact is presented in the **Results-Summary** sheet.

5.4 Limitations

The factors derived for this method were calculated from outputs of the Department for Transport (DfT) National Transport Model (NTM) which uses an aggregate demand model to simulate travel

behavioural responses for Great Britain. In common with all models, it must necessarily be incomplete and imperfect. Particular elements to note in this regard are:

- The tests used were based on responses in a forecast year (2020).
- The NTM base year and calibration is now somewhat out of date.
- Car km change can be caused by many factors. In this case the tests concerned the response to changes in fuel cost. While this does only impact car directly (as intended) it is essentially equivalent to a distance-based charge rather than an area-based charge (such as the Central London Congestion Charging Scheme or a Low Emissions Zone). Thus the behavioural response to a cost increases for destination choice while retaining the car mode is primarily to reduce distance driven rather than simply change destination (as a LEZ might induce) which may cause some unreliability in the application of the method to LEZ modelling or other AQ policy impacts.
- The changes in both car km and modal trips are calculated for all trips **from** a given area type to all destinations, rather than simply **within** an area type, as this was the only way to ensure that no suppression of trips was included in the factors (since the tests caused a change in trips between intra-area and inter-area).
- Unlike the MEC impacts, modal shift is only calculated using five year intervals and does not allow for individual years between intervals as inputs.

Nevertheless, the use of the NTM model has produced mode shift factors which are based on a much more comprehensive set of inputs than were available otherwise from a literature survey (as conducted earlier in this study). The NTM is also the source of the factors used in other impact calculations within this study as well as the official UK government National Road Traffic Forecasts. It therefore offers good consistency with other elements of the current model and national policymaking.

Ensuring that there was no overall suppression or generation of trips (zero deadweight loss) was also a benefit of this method over results from literature and was a stated requirement of Defra.

6. Method to assess health impacts from cycling and walking

6.1 Overview

Active forms of travel such as walking and cycling are the most sustainable forms of transport and are associated with a number of health benefits including a reduced risk of premature death and prevention of chronic diseases such as heart disease, stroke, depression, dementia and cancer.

The increased use of car has been a deterrent factor of walking and cycling in the UK. The lack of investment in walking and cycling infrastructure and a poor urban design has resulted in the decline of the active travel[10]. The suppression of active travel is linked with higher level of physical inactivity and sedentary lifestyles contributing to high level of morbidity and mortality. Transport interventions have important potential impacts on health and equality and should be taken into consideration by policy makers to promote general improvement in the lifestyles and wellbeing of local populations[11]. Some of the benefits of cycling and walking include improvement of mental health and wellbeing; reduction of weight and stress management; improvement of air quality and noise; reduction of energy consumption and CO_2; reduced congestion; and more liveable communities[12].

This section of the model is based on the most updated version of WebTAG Use of Cycle & Walking Business Case Toolkit to date, which is currently under development by the DfT, and uses the principles developed for the Health Economic Assessment Tool[13] (HEAT) for calculating health benefits for walking and cycling. HEAT was developed by the WHO (World Health Organisation) for use in Ministry of Health funded workshops to increase the capacity of the health sector and estimate reductions in mortality due to cycling (transportation) and walking (recreation and transportation). User inputs are usually obtained by destination based surveys, travel surveys, traffic counts, route user surveys and pedometers. There are two types of assessments when using HEAT tool:

1. Using data from a single point in time; this option is used when assessing the status quo, such as valuing current levels of walking and cycling in a city or if data on the results of an intervention only are available; and

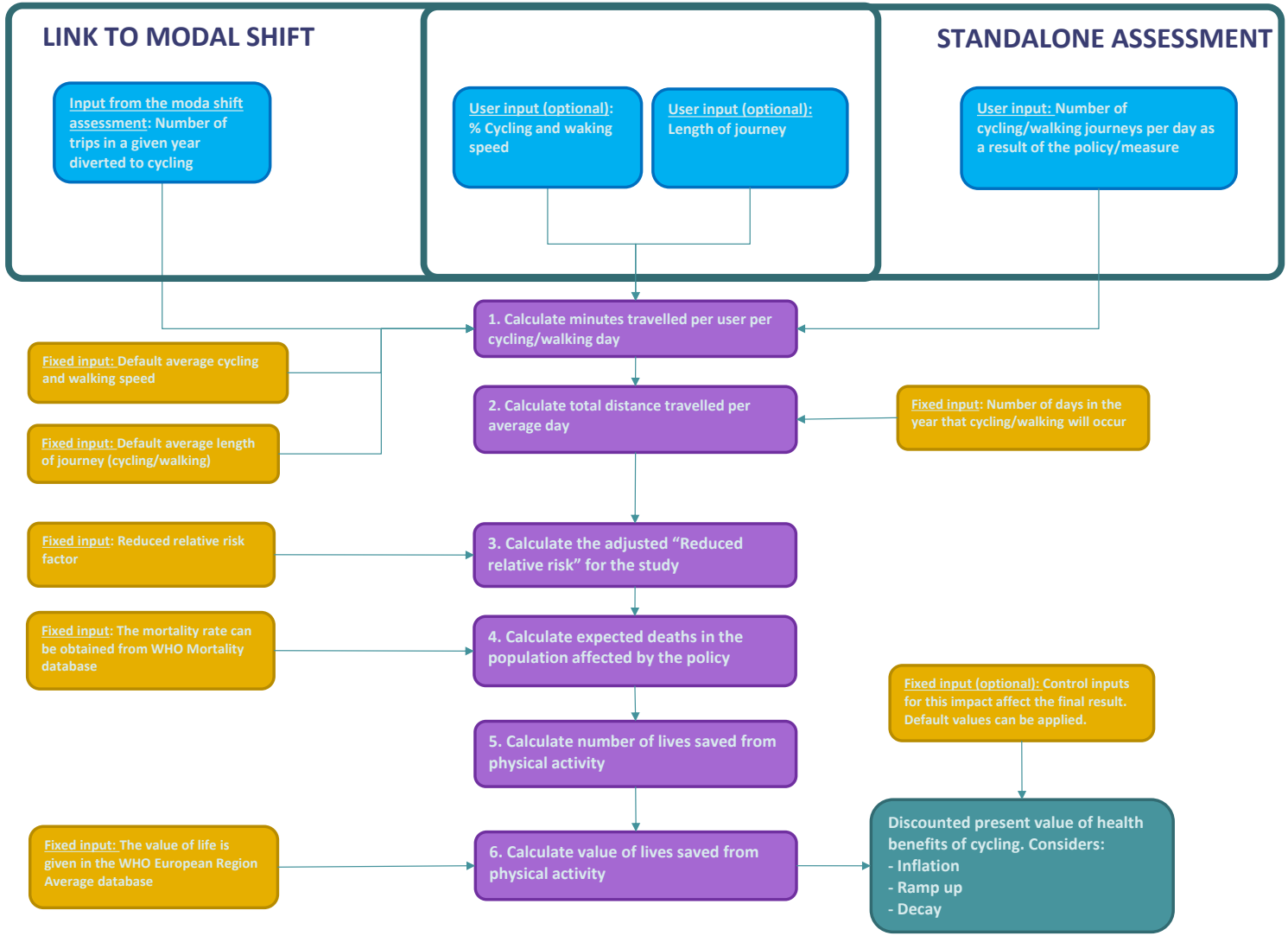
2. Using before and after data; it is used when assessing the impact of an actual intervention or hypothetical scenarios. Pre and post measures will be used to calculate health benefits and associated financial savings.

We apply the second type of assessment following the same approach as WebTAG Use of Cycle & Walking Business Case Toolkit. It is based on a reduction in the risk of dying prematurely due to physical activity and it is directly related to minutes of cycling/walking.

The model includes four modules, developed in four separate sheets. The first two modules use inputs from modal shift (see section 5). They monetise the health benefits of the number of trips being diverted into cycling and walking separately. The third and fourth modules allow for assessment of health impacts from cycling and walking in separate sheets and independently from the modal shift impact. Figure 6.1 below presents an overview of the modules and steps required to assess the impact.

[10] Healthy transport=Healthy lives, British Medical Association, July 2012
[11] Devon and Torbay Local Transport Plan 2011 – 2026, Equality and Health Impact Assessment, Devon County Council, January 2011
[12] Bristol City Council
[13] Health economic assessment tools (HEAT) for walking and cycling, Economic Assessment of Transport Infrastructure and Policies, World Health Organisation, Methods and user guide, 2014 update

Figure 6.1 Overview of the methodology to assess health impacts of cycling and walking



6.2 Inputs

Inputs used to calculate the health impact of cycling are summarised in Table 6.1 below. If the source for an input is “User/ Default” means that default values are already pre-populated in the model but the user can modify them to suit their needs.

Table 6.1 Summary of inputs – health impacts of cycling

Input	Units	Comment	Source
User inputs for the standalone assessment only:			
Number of cycling/walking journeys per day as a result of the policy/measure	Number of journeys	The user needs to input the number of cycling and walking journeys separately. These are the journeys resulting from the policy or measure.	User
User inputs for both standalone assessment and modal shift approach:			
Length of cycling/walking journeys.	Km	These inputs are relevant for the policies which will change the length of the cycling or walking trip. For example construction of new cycling route can decrease or increase the overall distance travelled on a bike. Inputs for cycling and walking have to be input separately	User / Default values applied if left blank
Cycling/walking speed	Km/h	Together with journey distance, it is used for estimating cycling/walking time.	User / Default values applied if left blank
Decay rate	%	The rate at which health benefits decay (i.e. after the end of the policy/measure)	User / Default values pre-populated in cell
Year decay start	Year	Year in which decay starts (i.e. when funding for a cycling scheme ends)	User / Default values pre-populated in cell
Ramp up of health benefits	Year	The number of years it takes for the measure/policy to achieve full potential.	User / Default values pre-populated in cell
Number of days in the year that cycling/walking would occur	Number of days	Number of days per year that the number of journeys per day entered will apply.	User / Default values pre-populated in cell
Share of journeys (both from walking and cycling) that form part of a return trip	%	This is to identify the number of users affected by the policy.	User / Default values pre-populated in cell
Background annual growth	%	Expected annual growth in per cent.	User / Default values pre-populated in cell
Inputs for the assessment linked to modal shift only			
Number of trips diverted to cycling	Number of trips	This input feeds in from the assessment of modal shift impact	Assessment of the modal shift impact
Fixed Inputs for both assessment methods:			
Value of life saved.	£ in 2010 prices	The economic value of a saved life.	WHO European Region Average
Mean proportion of England and Wales population aged 15-64 who die each year from all	percentage	This is the total proportion of people who die from all causes in England and Wales.	WHO European Detailed Mortality Database for age group averages, or can be user defined to the locale of the

Input	Units	Comment	Source
causes			scheme.
Reduced relative risk index for cycling and walking	index	The value used for cycling is from a Copenhagen study which puts a cap on the index at 0.28. This is associated with 36 min cycling per day. In the case of walking the index is 0.22, associated with 21.5 min walking per day.	Copenhagen Centre for Prospective Population studies[14]
Average cycling trip length	Kilometres	This input provides an average length travelled per cyclist per trip.	TAG UNIT A5.1 (Citing NTS)
Average cycling speed	Kilometres per hour	This input provides an average cycling speed to be used as default value.	TAG UNIT A5.1 (Citing DMRB 11.8.3)
Average walking trip length	Kilometres	This input provides an average length travelled per walking trip.	TAG UNIT A5.1 (Citing NTS)
Average walking speed	Kilometres per hour	This input provides an average walking speed to be used as default value.	TAG UNIT A5.1 (Citing DMRB 11.8.3)

The **user inputs** required to calculate the impact when linked to modal shift assessment are:

- **Number of cycling/walking journeys per day as a result of the policy/measure:** This mandatory input is used in the standalone assessment to calculate the number of users that will benefit from the policy. This input has to be provided separately for cycling and walking.
- **Average length of the cycling/walking journey (km)**: How far users will cycle (e.g. distance between home and work for new cycling commuters). Used to calculate the average journey time together with average cycling/walking speed.
- **Average cycling/ walking speed:** Together with the previous input, it is used to calculate the average journey time. If either length or speed is left blank for a specific year, default journey times will be applied.

The three inputs described above have to be entered separately for cycling and walking in separate tables.

[14] Andersen LB et al. All-cause mortality associated with physical activity during leisure time, work, sports and cycling to work. Arch Intern Med. 2000;160:1621–8

Box 23 Number of cycling journeys per day, average length and average speed

Number of cycling journeys per day as a result of the policy/measure is to be entered by the user in **Control** "Table 3" (rows 116:118). Average length of the cycling journey must be entered in km in **Control** "Table 3" (rows 119:121). Average cycling speed must be entered in km/h in **Control** "Table 3" (rows 122:124). They must entered for each year within the appraisal period.

Number of cycling journeys per day is mandatory in order to do a standalone assessment but it is not necessary for the assessment linked to modal shift. Average length of journey and speed are used to calculate average cycling time in both the standalone assessment and the modal shift approach. Length of journey and speed are not mandatory. If they are not entered, default values will be used in the calculations. For each input, the user can enter different values for each uncertainty scenario (central, low, high). User can also select qualitative uncertainty scores from the drop down lists in column AN.

The same three inputs are to be entered separately for walking in **Control** "Table 4" (rows 131:133) for number of walking journeys, **Control** "Table 4" (rows 134:136) for average length and **Control** "Table 4" (rows 137:139) for average walking speed.

Table 3 User inputs for health impacts of cycling

		2015	2016	2017	2018	2019
Number of cycling journeys per day as a result of the policy/measure	Central	1,000	1,000	1,000	1,000	1,000
	Low	500	500	500	500	500
	High	2,000	2,000	2,000	2,000	2,000
Average length of the cycling journey (km)	Central	5	5	5	5	5
	Low	2	2	2	2	2
	High	7	7	7	7	7
Average cycling speed (km/h)	Central	20	20	20	20	20
	Low	20	20	20	20	20
	High	20	20	20	20	20

All the inputs from **Control** "Table 3" (rows 116:124) are carried forward into **Calculations-Health (SA-cycle)** (rows 22:30). All the inputs from **Control** "Table 4" (rows 131:139) are carried forward into **Calculations-Health (SA-walk)** (rows 22:30). Average cycling length and speed **Control** "Table 3" (rows 119:124) also feed into **Calculations-Health (MS-cycle)** (rows 25:30). Average walking length and speed **Control** "Table 4" (rows 134:139) also feed into **Calculations-Health (MS-walk)** (rows 25:30)

- **Control inputs for health benefits:** Table 5 contains a series of control factors and inputs that affect different steps of the calculations. They are pre-populated with default inputs in case the user do not have specific values, but they can be modified in order to suit the user needs. Inputs in Table 5 are:
  - Decay rate: The rate at which health benefits decay (i.e. after the end of the policy/measure). Default value is zero, assuming the improvement is permanent (e.g. infrastructure) or the end of the policy is beyond the appraisal period.
  - Year decay start: Year in which decay starts (i.e. when funding for a cycling scheme ends). Default value is the end year of appraisal, making decay ineffective.
  - Ramp up of health benefits: The number of years it takes for the measure/policy to achieve full potential. Default value is five years (Source: WebTAG toolkit).
  - Number of days in the year that cycling/walking would occur: Number of days per year that the number of journeys per day entered will apply. This is different for cycling and walking. Default number of cycling days is 260 weekdays per year. Default number of walking days is 365 days a year.
  - Share of journeys (both from walking and cycling) that form part of a return trip: This is to identify the number of users affected by the policy. The model is originally design for commuters that usually cycle or walk both ways. If the user inputs regarding number of trips, distance and speed refer to individual (one way) journeys, this should be set to zero. Default value is 90% (Source: WebTAG toolkit).
  - Background annual growth: Expected annual growth in %. This input is used in case the user assumes that value of life will grow over time. Default value is zero, value of life remains constant.

Box 24 Control inputs for health benefits

The control inputs described above can be entered by the user in **Control** "Table 5 Control inputs for health benefits" (rows 142:152). User can choose to use pre-populated values as default. Inputs here will not reset so if the user changes them, default values should be manually re-entered. Comments in column G details the default values. Values in Table 5 apply to all scenarios (central, low and high).

Table 5 Control inputs for health benefits

			Uncertainty		Comments
			Qualitative	Score	
146	Decay rate (%)	0%	not used	1	Default 0%
147	Year decay starts	2030	not used	1	Default: Assessment end year
148	Ramp up of health benefits (years)	5	not used	1	Default: 5
149	Number of days in the year that cycling would occur	260	not used	1	Default of 260 weekdays per year
150	Number of days in the year that walking would occur	365	not used	1	Default of 365 days per year
151	Share of journeys (both from walking and cycling) that form part of a return trip	90%	not used	1	This is to identify the number of users affected by the policy. Default is 90%.
152	Background annual growth (%)	0.00%	not used	1	Value of lives saved will grow at the defined rate. Default is zero.

These data are carried forward into **Calculations-Health (MS-cycle)**, **Calculations-Health (MS-walk), Calculations-Health (SA-cycle)**, **Calculations-Health (SA-walk)** (rows 9:15).

The **fixed inputs** required to calculate the impact are:

Value of life saved – this is an economic value of life saved. This figure is based on values from WHO and is a European Region Average.

Mean proportion of England and Wales population aged 15-64 who die each year from all causes – this input is sourced from WHO European Detailed Mortality Database http://data.euro.who.int/dmdb/. For local assessments, this value can be updated with the local statistics.

Reduced relative risk index for cycling - The value used for cycling is from a Copenhagen study which puts a cap on the index at 0.28 for 1620 km cycled annually per new user. WebTAG toolkit matched it to 36 minutes cycling per working day. Unless alternative studies of similar scope are identified, this input is not expected to be updated by the users in the future.

Reduced relative risk index for walking – Obtained from HEAT, WebTAG toolkit matched it to 21.5 minutes walking per working day.

Average cycling and walking trip length and duration – These inputs are used as a default value in case the user does not specify average distance and speed. They are both sourced from TAG Unit A5.1, citing data from the National Transport Survey and DMRB 11.8.3.

Box 25 Fixed inputs for the assessment of health impacts of cycling

Factors for health benefits impacts are presented in **Inputs-traffic** (rows 166:178). As the inputs come from a range of sources these values are not shown in a format consistent to the original source. For each of these impacts the user can assign an uncertainty score in column H. The uncertainty scores have been estimated by the authors of the model.

	Factors for health benefits impact							
167								
168								
169	**Factor**	**Value**	**Unit**	**Year**	**Uncertainty score**		**Source**	**Notes**
170	**Value of life**	1,653,687	£	2010	low	2	WHO European Region Average	
171	**Mean proportion of England and Wales population ages 15-64 who die each year from all causes**	0.24%	%	-	low	2	WHO European Detailed Mortality	
172	**Reduced relative risk index for cycling**	0.28	-	-	low	2	Andersen LB et al. All-cause mort.	
173	**Reference minutes cycled per day**	36.00	minutes		not used	1	WebTAG toolkit A5.1, based on WI	
174	**Reduced relative risk index for walking**	0.22	-	-	low	2	Andersen LB et al. All-cause mort.	
175	**Reference minutes walked per day**	21.50	minutes		not used	1	WebTAG toolkit A5.1, based on WI	
176	**Trip duration related data:**							
177	**- Average cycling trip length**	3.9	km	2014	low	2	8	Apendix B case st
178	**- Average cycling speed**	20.0	km/h	2014	low	2	8	Apendix B case st
179	**- Average walking trip length**	1.2	km	2014	low	2	8	Apendix B case st
180	**- Average walking speed**	5.0	km/h	2014	low	2	8	Apendix B case st

These data are carried forward into **Calculations-Health (MS-cycle)**, **Calculations-Health (MS-walk), Calculations-Health (SA-cycle)**, **Calculations-Health (SA-walk)** (rows 37:44)**.**

6.3 Calculations

Calculations are undertaken in the following worksheets: **Calculations-Health (MS-cycle)**, **Calculations-Health (MS-walk)** – these include calculations for the impact when linked to modal shift for cycling and walking respectively**, Calculations-Health (SA-cycle)**, **Calculations-Health (SA-walk) –** these provide calculations for the impact when a standalone assessment is undertaken for cycling and walking respectively.

Each step of the assessment method is described below.

Description for assessment linked to the modal shift impact (cycling)

This section describes step-by-step the methodology to calculate impact on health from cycling when using outputs of the modal shift assessment. Across the steps, an IF function is used to leave the cells blank for those years outside the appraisal period. Impact on health from walking follows the same methodology as the one described here.

- Step 1: Calculate minutes travelled per user per cycling day

In this step the average minutes cycled per day per user are calculated. If the user inputs average length and speed were entered, minutes travelled are calculated by dividing length (km) by speed (km/h). The share of journeys that form part of a return trip is also taken into account (i.e. if set to zero, it will consider the specified distance will be cycled once per user).

If the user does not input the information on average distance and speed on the Control tab, default values from the TAG Unit will be used.

Box 26 Calculate minutes travelled per user per cycling day

This step is calculated in **Calculations-Health (MS-cycle)** rows 70:72. Average trip distance and speed for each year is feeding from **Calculations-Health (MS-cycle)** rows 25:30. Share of journeys that form part of a return trip is feeding from "Control for health benefits" table in **Calculations-Health (MS-cycle)** cell C14. The calculations are made for each year of the assessment period.

Step 1. Calculate minutes travelled per user per cycling day

Description: Calculates the total minutes cycled per day considering distance, speed and the proportion of trips that are return trips.

Step inputs:

Input	Units	Uncertainty score
Average length of the cycling journey (km) (from us	km	1
Average cycling speed (km/h) (from user inputs)	km/h	1
Share of journeys (both from walking and cycling) t	%	1

Step outputs:

Output	Units
Minutes cycled per day	minutes

Calculations

		2015	2016	2017	2018	2019	2020
Change in distance	Central		27.3	27.3	27.3	27.3	27.3
	Low		10.9	10.9	10.9	10.9	10.9
	High		38.2	38.2	38.2	38.2	38.2

Step qualitative uncertainty score: 1

These data are carried forward into step 2 of the calculations in **Calculations-Health (MS-cycle)** (rows 91:93) for the selected assessment period duration.

- **Step 2. Calculate minutes travelled per average working weekday** -

This step calculates the total minutes cycled per user per average working day, assuming 220 working days per year. The reason of adding this step is because, as modelled in the WebTAG toolkit, the risk reduction factor used later in the calculations is based on 220 days for cycling and 365 days for walking. This means that minutes cycled have to be weighted. This is done by multiplying the average minutes travelled per cycling day from Step 1 by number of days in the year that cycling would occur and dividing by 220.

Box 27 Calculate minutes travelled per average working weekday

This step of the calculations is undertaken in **Calculations-Health (MS-cycle)** rows 91:93 and uses data on the minutes travelled per user per cycling day from Step 1 in **Calculations-Health (MS-cycle)** rows 70:72 and number of days in the year that cycling would occur in **Calculations-Health (MS-cycle)** cell C12. The calculation is repeated for each year of the assessment period and for each uncertainty scenario (if data is provided by the user).

Step 2. Calculate minutes travelled per average working weekday

Description: Calculates the time travelled per average working weekday considering the number of days in the year that will be affected by the policy. A standard working year is

Step inputs:

Input	Units	Uncertainty score
Minutes cycled per day	minutes	1
Number of days in the year that cycling would occu	days	1

Step outputs:

Output	Units
Minutes travelled per working day	minutes

		2015	2016	2017	2018	2019	2020	2021
Distance per user per year	Central						32.23	32.23
	Low						12.89	12.89
	High						45.12	45.12

Step qualitative uncertainty score: 1

The outputs of this calculation feeds into Step 3 of the methodology in **Calculations-Health (MS-cycle)** rows 113:115.

- **Step 3: Calculate the adjusted "Reduced relative risk" for the study**

This step calculates the reduced relative risk index for users cycling as a result of the policy. According to the WebTAG toolkit, reduced relative risk index is 0.28 for a user cycling 36 minutes per working day. For shorter or longer journeys travelled the reduced relative risk index is scaled proportionally to the time travelled. A cap of 0.45 is in place based on the HEAT tool, meaning that this is the maximum benefit achievable by cycling.

Box 28 Calculate the adjusted "Reduced relative risk" for the study

This step of the calculations is undertaken in **Calculations-Health (MS-cycle)** rows 113:115 using minutes travelled per average working weekday (outputs of step 2 of the calculations in **Calculations-Health (MS-cycle)** rows 91:93); the reduced relative risk factor in cell C39 and the reference minutes cycled per day (36 minutes) from row 40.

The calculation scales the reduced relative risk factor depending on the number of minutes walked. A MIN function is used to ensure that no value larger than the cap of 0.45 is presented.

Step 3. Calculate the adjusted "Reduced relative risk" for the study

Description: "Reduced relative risk" is adjusted so any annual distance above 1620km/year results in a factor of 0.28. Shorter distances are scaled down proportionally.

Step inputs:

Input	Units	Uncertainty score
Reduced relative risk of cycling	-	2
Minutes travelled per working day	minutes	1
Reference minutes cycled per day	days	1

Step outputs:

Output	Units
Adjusted reduced relative risk	-

		2015	2016	2017	2018	2019	2020	2021
Adjusted reduced relative risk	Central						0.25	0.25
	Low						0.10	0.10
	High						0.35	0.35

Step qualitative uncertainty score: 2

The outputs of this calculation feeds into Step 5 of the methodology in **Calculations-Health (MS-cycle)** (rows 156:158).

Step 4: Calculate expected deaths in the population affected by the policy

This step calculates the number of deaths that would occur from all causes among cycling users. It is based on statistics of premature death per country.

Box 29 Calculate expected deaths in the population affected by the policy

This step of the calculations is undertaken in **Calculations-Health (MS-cycle)** rows 135:137 and uses mean proportion of England and Wales population ages 15-64 who die each year from all causes (cell C38) multiplied by the number of users, which is derived by the number of journeys (rows 22:24) and the proportion of trips that are return journeys (cell C14)

Step 4. Calculate expected deaths in the population affected by the policy

Description: This step calculated the number of deaths that will occur from all causes among new cycling users

Step inputs:

Input	Units	Uncertainty score
Mean proportion of England and Wales population	%	2
Daily cycling journeys (from modal shift)	journeys	4
Share of journeys (both from walking and cycling) t	%	1

Step outputs:

Output	Units
Expected deaths of target population	Number of deaths

		2015	2016	2017	2018	2019	2020	2021
Expected number of deaths	Central						0.00	0.00
	Low						0.00	0.00
	High						0.00	0.00

Step qualitative uncertainty score: 8

The outputs of this calculation feed into Step 5 of the methodology in **Calculations-Health (MS-cycle)** (rows 156:158).

Step 5: Calculate number of lives saved from physical activity

This step calculates the number of new cyclists that will have reduced risk of dying due to increased physical activity.

Box 30 Calculate number of lives saved from physical activity

This step of the calculations is undertaken in **Calculations-Health (MS-cycle)** rows 156:158. In this step adjusted relative risk index (outputs of step 3 in rows 113:115) is multiplied by the expected number of deaths in the population affected by the policy (outputs of step 4 in rows 135:137).

Step 5. Calculate number of lives saved from physical activity

Description: This step calculates the number of new cyclists that will not die due to increased activity

Step inputs:

Input	Units	Uncertainty score
Expected deaths of target population	Number of deaths	2
Adjusted reduced relative risk	-	2

Step outputs:

Output	Units
Lives saved from physical activity	Lives

		2015	2016	2017	2018	2019	2020	2021
Number of lives saved	Central		0.32	0.32	0.32	0.32	0.32	0.32
	Low		0.06	0.06	0.06	0.06	0.06	0.06
	High		0.91	0.91	0.91	0.91	0.91	0.91

The outputs of this calculation feed into Step 6 of the methodology in **Calculations- Health Impacts (MS)** (rows 186:188).

- **Step 6: Monetise value of lives saved from physical activity -**

This step assigns a monetary value to the lives saved due to greater physical activity.

Box 31 Monetise value of lives saved from physical activity

This step of the calculations is undertaken in **Calculations-Health (MS-cycle)** rows 186:188. In this step the number of lives saved (outputs of step 5 in rows 156:158) is multiplied by the value of life (cell C37). Annual growth, decay and ramp up are also considered on this step in rows 181, 182 and 183 respectively. They feed from cells C15, C9 and C11. They are calculated for every year within the appraisal period and multiplied as modifiers to the monetised value of life.

Step 6. Monetise value of lives saved from physical activity

Description: A specific monetary value is awarded to each of the lives saved

Step inputs:

Input	Units	Uncertainty score
Lives saved from physical activity	Lives	16
Value of life	£	2
Background annual growth (%)	%	1
Decay rate (%)	%	1
Year decay starts	year	1
Ramp up of health benefits (years)	years	1

Step outputs:

Output	Units
Value of lives saved	£

	2015	2016	2017	2018	2019	2020	2021
Annual growth	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Decay	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Ramp up	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.4000

		2015	2016	2017	2018	2019	2020	2021
Value of lives saved	Central						7	13
	Low						1	3
	High						18	37

Step qualitative uncertainty score: 32

The outputs of this calculation feed into Step 7 of the methodology in **Calculations-Health (MS-cycle)** (rows 210:212).

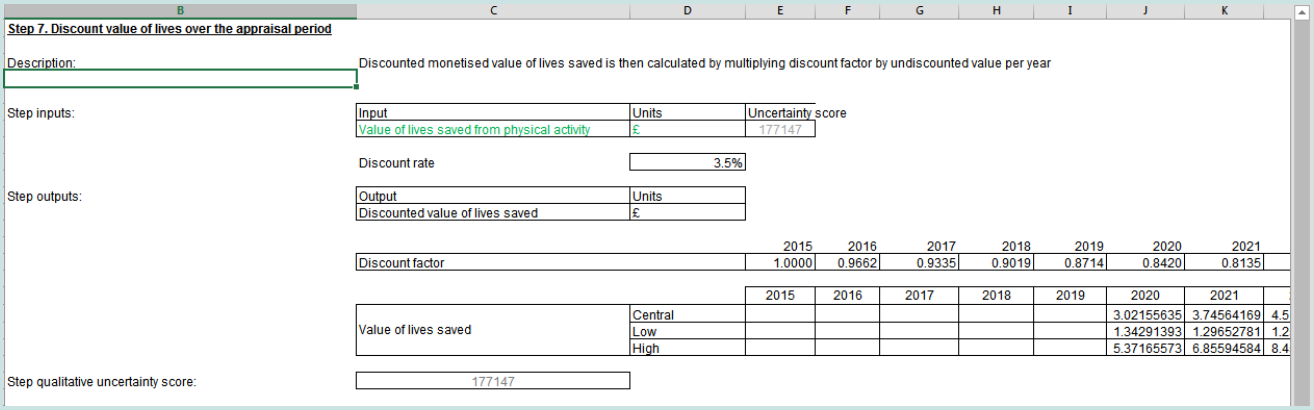
- **Step 7: Discount value of lives saved over the appraisal period**

In this step discounted monetised value of lives saved is calculated by multiplying discount factor by undiscounted value per year.

Box 32 Discount value of lives saved over the appraisal period

For each uncertainty scenario, the total discounted value of lives saved for each year in the assessment period is calculated in rows 210:212. The total discounted values are then adjusted for inflation in rows 229:231 (see information in Box 2).

A discount factor is calculated in **Calculations-Health (MS-cycle)** row 207 for each year of the assessment. The reference year is picked up from the **Control** (cell C12). The years for which discount factors are calculated are presented in **Calculations-Health (MS-cycle)** (row 206). The multiple IF functions are used to calculate the correct discount factor for the year in row 206. For the reference (current) year and all years before the reference year, the discount factor is 1. For the years beyond the reference year, the discount factor is calculated using the discount rate in **Calculations-Health (MS-cycle)** (cell D201, which is fed from **Control**, cell C35).



Step 7. Discount value of lives over the appraisal period

Description: Discounted monetised value of lives saved is then calculated by multiplying discount factor by undiscounted value per year

Step inputs:

Input	Units	Uncertainty score
Value of lives saved from physical activity	£	177147

Discount rate: 3.5%

Step outputs:

Output	Units
Discounted value of lives saved	£

	2015	2016	2017	2018	2019	2020	2021
Discount factor	1.0000	0.9662	0.9335	0.9019	0.8714	0.8420	0.8135

		2015	2016	2017	2018	2019	2020	2021	
Value of lives saved	Central						3.02155635	3.74564169	4.5
	Low						1.34291393	1.29652781	1.2
	High						5.37165573	6.85594584	8.4

Step qualitative uncertainty score: 177147

Description for assessment linked to the modal shift impact (walking)

In the previous section the methodology followed for the calculation of health impacts of cycling linked to modal shift has been detailed. Health impacts of walking linked to modal shift are calculated in the sheet **Calculations-Health (MS-walk)** following an identical methodology and cell references. The only difference are the inputs listed in the table below:

Table 6.2 Difference in inputs between cycling and walking

Input in cycling	Input in walking	Location of the walking input within Calculations-Health (MS-walk)
Number of days in the year that cycling would occur	Number of days in the year that walking would occur	Cell C13
Daily cycling journeys (from modal shift)	Daily walking journeys (from modal shift)	Rows 22:24
Average length of the cycling journey (km) (from user inputs)	Average length of the walking journey (km) (from user inputs)	Rows 25:27
Average cycling speed (km/h) (from user inputs)	Average walking speed (km/h) (from user inputs)	Rows 28:30
Reduced relative risk of cycling	Reduced relative risk of walking	Row 41
Reference minutes cycled per day	Reference minutes walked per day	Row 42

Description for the standalone assessment

The standalone assessment of health impacts is calculated in Calculations-Health (SA-cycle) for cycling and Calculations-Health (SA-walk) for walking. They follow exactly the same methodology and cell position than the method linked to modal shift. The only difference is that the inputs on number of journeys per day, instead of feeding from modal shift, they feed from user inputs: **Control** "Table 3" (rows 116:118) for cycling and **Control** "Table 4" (rows 131:133) for walking.

6.4 Results-health impacts and results-summary

The calculation assessment in the previous section provides the Discounted (present value) impact in **Calculations-Health (MS-cycle)**, **Calculations-Health (MS-walk), Calculations-Health (SA-cycle)**, **Calculations-Health (SA-walk)** (rows 229:231).

Box 33 Discounted (present value) impact – all Health Impact sheets

The final output is presented in **Calculations-Health (MS-cycle)**, **Calculations-Health (MS-walk), Calculations-Health (SA-cycle)**, **Calculations-Health (SA-walk)** (rows 229:231).

For each uncertainty scenario, the total discounted health benefits are fed from rows 210:212. The total discounted benefits are then adjusted for inflation.

Final impact output

Description:	Discounted (present value) of lives saved in target year prices									
Units	k£ (2014 prices)									
Inflation:	Input	Year	Value	Uncertainty score						
	GDP deflator (2013 = 100)	2010	94.68	2						
	GDP deflator (2013 = 100)	2014	102.30							
Final output:	**Discounted (Present Value) impact**	2015	2016	2017	2018	2019	2020	2021	2022	
	Central						0.00	0.00	0.00	
	Low						0.00	0.00	0.00	
	High						0.01	0.01	0.01	
Output qualitative uncertainty score:	354294	still need to run scenarios to get uncertainty score range colours to then feed in to Results shee								

The GDP deflators used for the inflation adjustment are presented in rows 224:225 for:

- The reference year in which value of life are presented (see cell E37 feeding from **Inputs-traffic,** cell G170)
- The year to which the costs / benefits should be inflated / deflated (see cell E49 feeding from **Control**, cell C15

The final outputs from the calculation sheets feed into the **Results-Health Impacts** and **Results-Summary** sheets.

Results-Health Impacts worksheet brings together the results of the assessment of the impact standalone and when linked to modal shift for both cycling and walking.

Box 34 Results-Health Impacts

Results from the health impacts assessment are presented in **Results-Health Impacts** in four separate tables:

- Impact to society / individual - Modal shift approach: Cycling – rows (8:25) – this provides results from the cycling assessment linked to modal shift only. Qualitative uncertainty category is presented in cell E24.
- Impact to society / individual - Modal shift approach: Walking (rows 26:43) – this provides results from the walking assessment linked to modal shift only. Qualitative uncertainty category is presented in cell E42.
- Impact to society / individual - Standalone approach: Cycling (rows 44:61) – this provides results of the assessment of impacts of cycling from the standalone assessment. Qualitative uncertainty category is presented in cell E60.
- Impact to society / individual - Standalone approach: Walking (rows 62:78) – this provides results of the assessment of impacts of walking from the standalone assessment. Qualitative uncertainty category is presented in cell E78.

Box 34 Results-Health Impacts

Results - Health impacts of cycling

This worksheet contains the following results:

Impact to society / individual - Modal shift approach: Cycling
Impact to society / individual - Modal shift approach: Walking
Impact to society / individual - Standalone approach: Cycling
Impact to society / individual - Standalone approach: Walking

Colour key: Current year; Measure start year; Appraisal end year

Impact to society / individual – Modal shift approach: Cycling

Units: £'000s			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Costs	Transition cost	Central																	
		Low																	
		High																	
	Annual cost	Central																	
		Low																	
		High																	
Benefits	Transition benefit	Central																	
		Low																	
		High																	
	Annual benefit	Central						-0.01	-0.01	-0.02	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	
		Low						0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	
		High						-0.02	-0.03	-0.05	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	

Results qualitative uncertainty score:	64

Impact to society / individual – Modal shift approach: Walking

Units: £'000s			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Costs	Transition cost	Central																	
		Low																	
		High																	
	Annual cost	Central																	
		Low																	
		High																	
Benefits	Transition benefit	Central																	
		Low																	
		High																	
	Annual benefit	Central						-0.04	-0.07	-0.10	-0.10	-0.15	-0.15	-0.14	-0.14	-0.14	-0.13	-0.13	
		Low						-0.02	-0.03	-0.05	-0.05	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06	
		High						-0.07	-0.14	-0.20	-0.19	-0.31	-0.30	-0.29	-0.28	-0.27	-0.26	-0.25	

Impact to society / individual – Standalone approach: Cycling

Units: £'000s			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Costs	Transition cost	Central																	
		Low																	
		High																	
	Annual cost	Central																	
		Low																	
		High																	
Benefits	Transition benefit	Central																	
		Low																	
		High																	
	Annual benefit	Central						-37.21	-187.84	-272.23	-350.70	-423.56	-409.23	-395.39	-382.02	-369.10	-356.62	-344.56	
		Low						-13.44	-37.57	-54.45	-70.14	-169.42	-163.69	-158.16	-152.81	-147.64	-142.65	-137.83	
		High						-272.18	-525.96	-762.26	-981.97	-948.77	-916.68	-885.68	-855.73	-826.79	-798.84	-771.82	

Results qualitative uncertainty score:	16

Impact to society / individual – Standalone approach: Walking

Units: £'000s			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Costs	Transition cost	Central																	
		Low																	
		High																	
	Annual cost	Central																	
		Low																	
		High																	
Benefits	Transition benefit	Central																	
		Low																	
		High																	
	Annual benefit	Central						-116.33	-224.73	-243.36	-413.63	-506.87	-488.73	-473.17	-457.17	-441.71	-426.77	-412.34	
		Low						-58.16	-112.40	-121.68	-209.84	-253.44	-244.87	-236.58	-228.58	-220.85	-213.39	-206.17	
		High						-232.66	-449.58	-486.71	-839.38	-1013.74	-979.46	-946.34	-914.34	-883.42	-853.54	-824.68	

Results qualitative uncertainty score:	16

The Net Present Value (NPV) for the assessment of the health benefit impact is presented in sheet **Results-Summary** (Rows 59:69). These present the sum of the results for the standalone assessment and the assessment linked to modal shift.

Health impacts of cycling

npv	Costs									Benefits									Total Net Present Value		
2014 prices	Total Transition			Average Annual			Total annualised costs			Transition benefit			Annual benefit			Total annualised benefits					
£'000s	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High
Impact to business																					
Impact to regulator																					
Impact to society				-	-	-							- 43,058	- 28,083	- 89,129						
Total impact				-	-	-	-	-	-				- 43,058	- 28,083	- 89,129	- 43,058	- 28,083	- 89,129	- 43,058	- 28,083	- 89,129

6.5 Limitations

- HEAT method is likely to produce conservative estimates as it does not account for disease-related benefits.
- HEAT method does not take into consideration differences in the intensity of cycling or the possibility that less well-trained individuals may benefit more from the same amount of cycling.
- The age groups who are usually evaluated using the HEAT method are adults, mainly because the most commonly studied disease end-points such as coronary heart attack or death are rare in children.
- HEAT method should not be used in population with high physical activity levels as the result could possibly underestimate the effect in very sedentary population groups.

7. Method to assess greenhouse gas impacts

7.1 Overview

Introducing new air quality policies are likely to result in changes to energy use and greenhouse gas (GHG) emissions. Generally the impacts of such policies are considered beneficial i.e. a measure designed to reduce air pollutants will also reduce GHG emissions and energy use (and vice versa for climate mitigation policies). For example, low emission zones or measures driving modal switch from road transport to rail/cycling will reduce both types of emissions. However this is not always the case such as some measures may result in an increase GHG emission (e.g. introduction of end-of-pipe abatement to reduce NO_X and primary particulate matter (PM) emissions), there will be occasions where trade-offs may exist.

In order to assess the beneficial or negative impact that air quality policies will have on climate change, the method developed here quantifies and values the net change in GHG emissions resulting from the implementation of air quality measures. It incorporates the valuation of the net change in energy use as well as of any direct rebound effects that might occur (i.e. in the case of energy efficiency policies). Changes in GHG emissions will generally be associated with net changes in energy use (i.e. fuel combustion). Monetisation of the changes allows the total net present value (NPV) to be derived that are associated with carbon, energy usage and cost-effectiveness of measures. It provides additional tools to conduct sensitivity analysis for different scenarios and to assess the cost-effectiveness of measures in terms of carbon and energy.

The model quantifies and monetises the net change in GHG emissions resulting from net changes in energy use where these energy changes have been quantified. For other measures (e.g. related to industrial process emissions) the method only allows monetisation of emissions if these have been quantified by the user and input to the model.

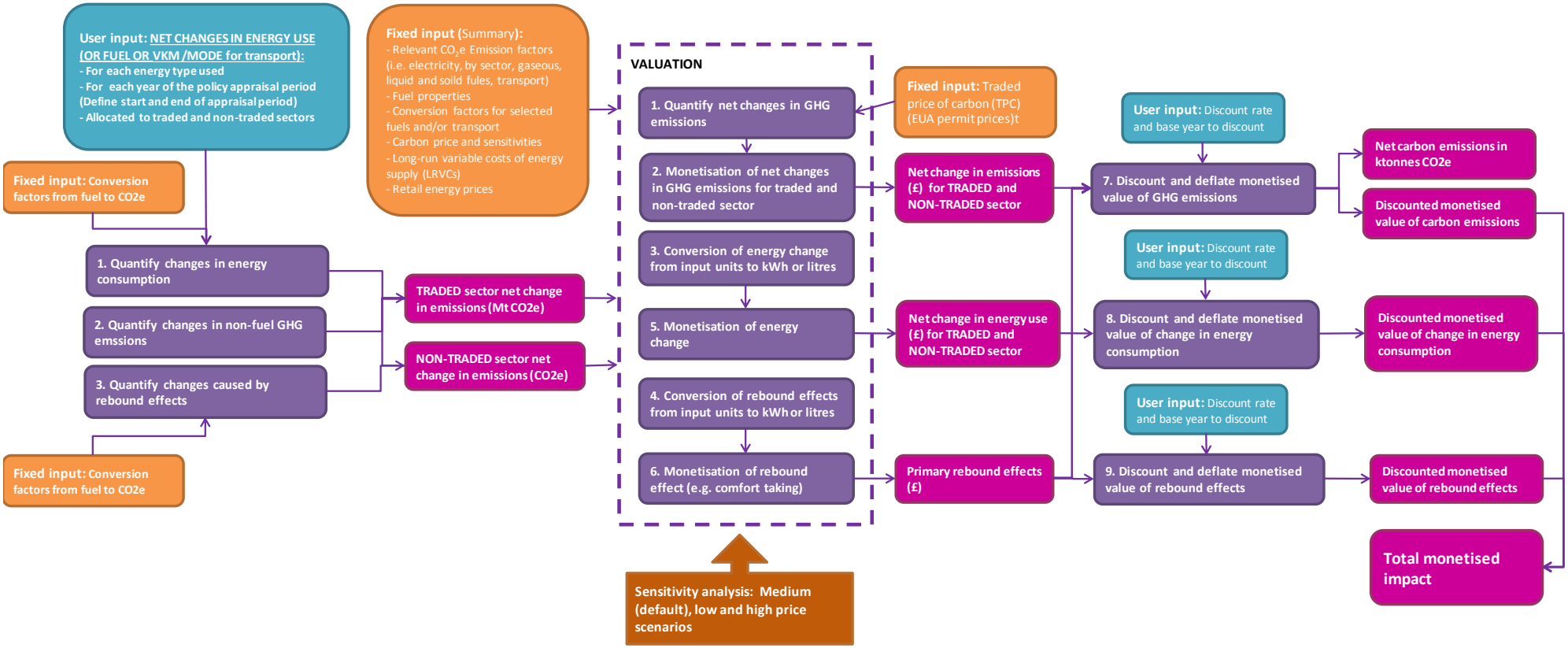
The method developed follows DECC's supplementary Green Book guidance and toolkit for quantifying and valuing changes in GHGs as well as energy use in policy appraisal[15]. The inputs for the assessment have been revised compared to the original DECC's toolkit, in order to align them with the inputs required for assessment of other impacts, and to improve the method's applicability to air quality measures. The module to value air quality impacts originally present in DECC's toolkit has been excluded from the method as detail assessment of this impact will be undertaken using other models available to Defra.

The primary limitation of this methodology is that it is restricted to identify changes in energy consumption as a result of a policy, and how this is reflected in changed GHG emissions. Changes related to non-fuel GHG emissions (e.g. formation of CO_2 through use of limestone in wet scrubbing) are not captured in the methodology. The change in the level of non-fuel GHG emissions will be variable depending on the technology or measure used and the sector to which it applies (i.e. how this leads to changes in process emissions). Therefore quantification on the basis of specific evidence was considered more suitable than the use of generic model results which would have high levels of uncertainty. If data on net changes in non-fuel GHG emissions are available, the user of the model is able to input them so that they are valued alongside energy related GHG emissions.

The model is not designed to calculate the embedded carbon associated with policies (unless the net energy change accounts for this) due to the high levels of uncertainty associated in such assessments and low availability of data on materials used.

[15] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Figure 7.1 Overview of the methodology to assess impacts on GHG



7.2 Inputs

Inputs used to calculate the impacts on GHG are summarised in Table 7.1 below.

Table 7.1 Summary of inputs – GHG

Input	Units	Comment	Source
User Inputs:			
Change in energy consumption	kWh/GWh	The user enters an estimate of the net change in energy consumption per sector (traded, non-traded, transport) for each year of the assessment. By sector, by vehicle change in fuel quantity or in vehicles litre, km, etc. Hydrocarbon oils are not included in traded emissions to be consistent with DECC IAG tool.	Assessment of the measure
Non-fuel GHG emissions	CO_2 eq	The user enters the change in GHG emissions not resulting from the change in fuels (e.g. change in embedded carbon). This change needs to be provided for the traded and non-traded sector.	Assessment of the measure
Rebound effects	Percentage rebound effects/ GWh or litres	If the policy is expected to result in a rebound effect, the user can enter this effect either as a percentage of the gross change in energy or as an absolute quantity (e.g. GWh or litres). These are generally based on assumptions of behavioural change which is inherently uncertain.	User selection
Fixed Input:			
Emission factors for different energy forms	kg CO_2e per unit (tonnes, kWh, Litres, Therms, km, passenger km)	Emissions factors to convert and standardise emissions in order to monetise appropriately the change in emissions, energy use and direct rebound effect for various sectors (i.e. traded, nontraded, transportation)	DECC, Defra, Greenhouse Gas Conversion Factor Repository
Carbon price, long-run variable cost of energy supply and retail energy price	£ per unit (tonne of CO_2 ,kWh or litre)	Monetising the change in emissions, energy use and direct rebound effects for traded and non-traded sectors.	DECC, HM Treasury,

When calculating impacts, uncertainty scenarios need to be taken into account. There are two ways to reflect the uncertainty of the inputs for the GHG assessment:

- **Quantitative** – The inputs for the model have been generated for three scenarios (central, low, high);
- **Qualitative** – There is only one set of inputs for the model (i.e. single scenario). This uncertainty score will be carried through the assessment.

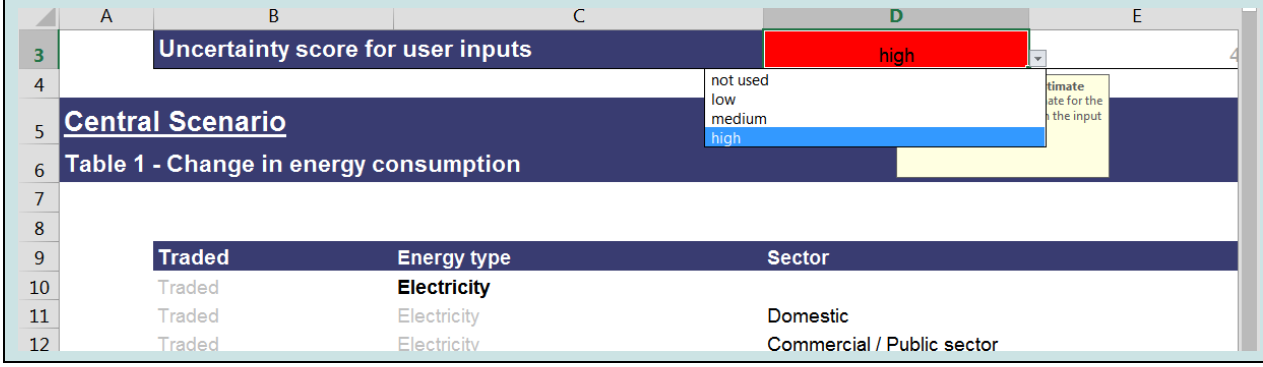
Box 35 Selecting uncertainty scenarios

The steps based on the selection of the medium uncertainty scenario (Central scenario) are described in the guide but the same steps apply to remaining uncertainty scenarios. User needs to select qualitative uncertainty score for the user input in cell D3.

- Quantitative – input the data in respective tables for the three scenarios:
  - For central scenario, input data in Control-GHG Rows 5-96
  - For low scenario, input data in Control-GHG row 97-188.
  - For high scenario, input data in Control-GHG row 189-278

In order to assist the user in adding the same inputs for all the scenarios, the central scenario can be used as a template. The low and high scenario will be automatically pre-populated with the information on sectors and fuels affected by the policy which were entered in Control-GHG Central Scenario Table 1: "Change in energy consumption". Values for low and high scenario should be entered for each cells for which the change in fuel was entered in the central scenario. If it is not done, the cells with missing information will be highlighted in light yellow.

- Qualitative –select the uncertainty scenario from cell D3 (either low, medium or high).

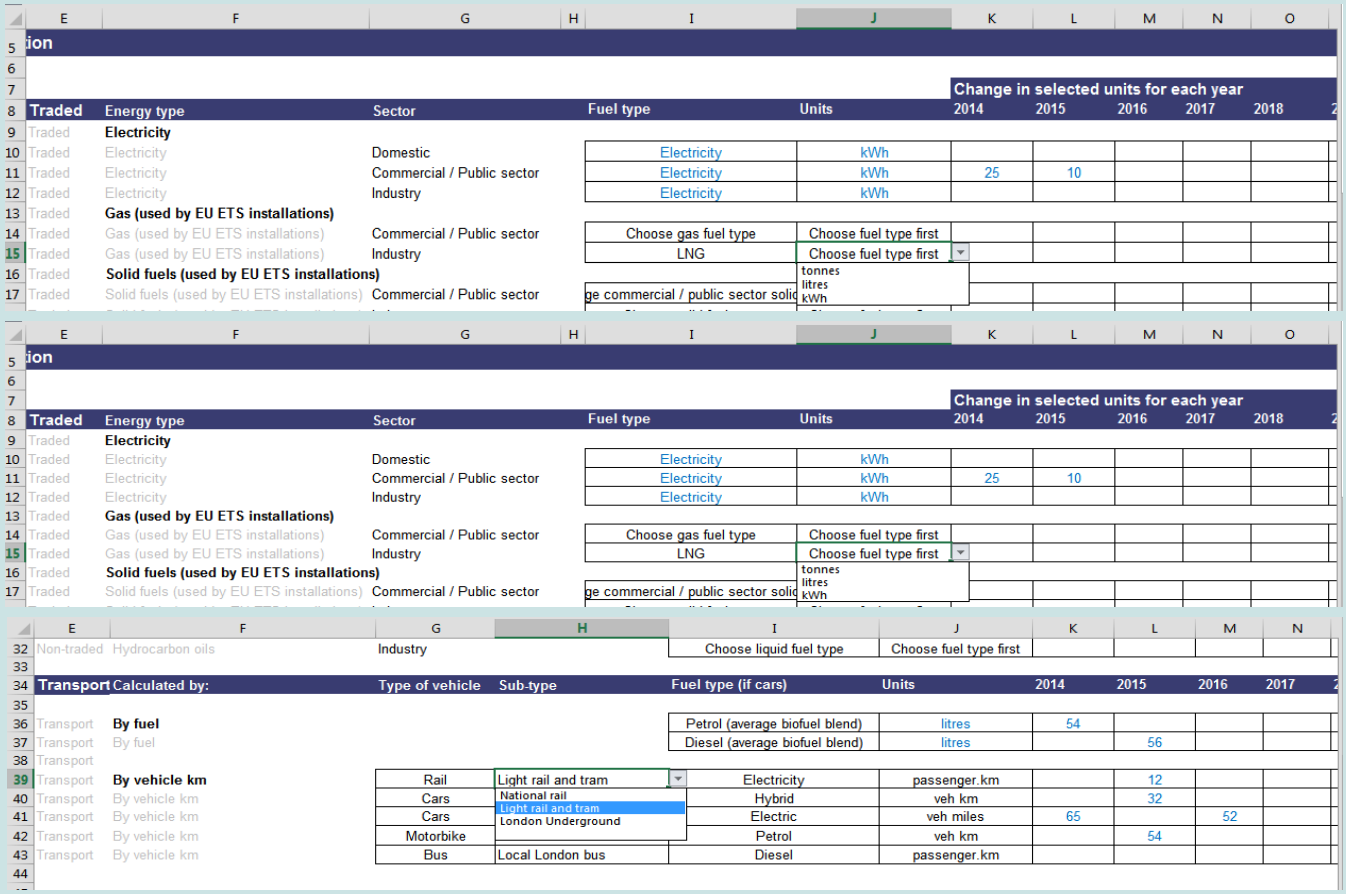


The input parameters required to calculate the impact are:

- **Net changes in energy use:** The model prompts the user to select the forms of energy use where changes are expected, differentiating between traded and non-traded sectors and where relevant between use in the commercial, domestic and industrial sectors. For each selected energy type, the user needs to insert the net change in energy use in each year of the appraisal period. The units of the data depend on the form of energy (e.g. GWh or litres).
- For road transport fuels, in addition to inserting changes expressed in litres, the user can provide changes in vehicle kms or modes of transport. In this case, the user is asked to specify the characteristics of the different types of vehicle affected (i.e. cars) and how the net change in vkm is distributed among different vehicles or mode types. Details of the vehicle types, sub-types and associated fuels are presented in Appendix B.
- This data determines the outputs of the model. The user is guided with explanation, options and examples to ensure this is entered correctly.

Box 36 Net changes in energy use

Change in energy use is entered by the user in Control –GHG table 1 depending on the scenario for any traded and non-traded or transportation sectors for each year of assessment. The user would be required to provide all electricity inputs in kWh, the different types of fuel or gas and use of road transport fuel in vehicle kilometres travelled. The user needs to input net change in energy (already accounting for any rebound effect).



	Traded	Energy type	Sector	Fuel type	Units	Change in selected units for each year 2014	2015	2016	2017	2018
9	Traded	**Electricity**								
10	Traded	Electricity	Domestic	Electricity	kWh					
11	Traded	Electricity	Commercial / Public sector	Electricity	kWh	25	10			
12	Traded	Electricity	Industry	Electricity	kWh					
13	Traded	**Gas (used by EU ETS installations)**								
14	Traded	Gas (used by EU ETS installations)	Commercial / Public sector	Choose gas fuel type	Choose fuel type first					
15	Traded	Gas (used by EU ETS installations)	Industry	LNG	Choose fuel type first					
16	Traded	**Solid fuels (used by EU ETS installations)**								
17	Traded	Solid fuels (used by EU ETS installations)	Commercial / Public sector	ge commercial / public sector solic						

tonnes
litres
kWh

	Transport	Calculated by:	Type of vehicle	Sub-type	Fuel type (if cars)	Units	2014	2015	2016	2017
32	Non-traded	Hydrocarbon oils	Industry		Choose liquid fuel type	Choose fuel type first				
34	**Transport**	**Calculated by:**	**Type of vehicle**	**Sub-type**	**Fuel type (if cars)**	**Units**	**2014**	**2015**	**2016**	**2017**
36	Transport	**By fuel**			Petrol (average biofuel blend)	litres	54			
37	Transport	By fuel			Diesel (average biofuel blend)	litres		56		
39	Transport	**By vehicle km**	Rail	Light rail and tram	Electricity	passenger.km		12		
40	Transport	By vehicle km	Cars		Hybrid	veh km		32		
41	Transport	By vehicle km	Cars		Electric	veh miles	65		52	
42	Transport	By vehicle km	Motorbike		Petrol	veh km		54		
43	Transport	By vehicle km	Bus	Local London bus	Diesel	passenger.km				

National rail
Light rail and tram
London Underground

These data are carried forward into Calculations-GHG for the selected assessment period duration. On the basis of the net changes in energy use (or vkm/mode) attributable to the policy entered by the user, the model quantifies the associated change of GHG emissions through the use of a set of emission factors. It also automatically values the changes in energy use and in emissions, and conducts a cost-effectiveness assessment.

- **Quantified changes of GHG emissions resulting from non-fuel measures (kg CO_2e):** These emissions are calculated by the user outside of the model. It is likely that they will have some level of uncertainty, which will vary depending on the measure and the assumptions made.

Box 37 Quantify changes of GHG emissions from non-fuel measures (kg CO_2e)

The model allows the user to assess the cost-effectiveness of a measure in terms of reducing GHG emissions. If the assessment results show that an air quality measure also provides good-value for money to reduce GHG emissions, this might be an additional justification for its introduction.

For changes in GHG emissions that do not result from changes in fuels (e.g. change in embedded carbon), this needs to be captured also for the traded and non-traded sectors. These are added to the **Control- GHG** sheet, *Table 2:"Non-fuel GHG emissions*" in Rows 47:52. These need to be expressed in tonnes of CO_2 eq.

Table 2 - Non-fuel GHG emissions

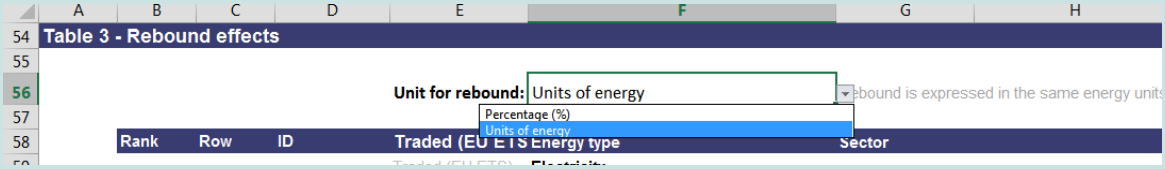
	Non-fuel GHG emissions	Traded / Non-traded	Units	Change in tonnes of CO2e 2014	2015
12	-51 Non-fuel emissions	Non-fuel emissions	Traded	tCO2e		6000
		Non-fuel emissions	Non-traded	tCO2e		5000

These data are carried forward into **Calculations-GHG (central, low and high)** for the selected assessment period duration.

- **Rebound effects:** If the policy is expected to result in a rebound effect, the user can enter this effect either as a percentage of the gross change in energy or as an absolute quantity (e.g. GWh or litres). These are generally based on assumptions of behavioural change which is inherently uncertain. For more information on the calculation of rebound effects and their limitations please refer to the DECC's guidance[16].

Box 38 Rebound effects

To enter the potential rebound effect, selection must first be made in cell C57 of the Control- GHG sheet Table 3: "Rebound effects". The model accepts inputs in per cent or units of energy.



Rows 55:94 and Columns F: G will be automatically pre-populated with the information on sectors and fuels affected by the policy which were entered in Control- GHG Table 1: "Change in energy consumption". In Columns H: AR enters the size of the anticipated rebound effect under the central scenario for each affected year. Rebound effects for low and high scenario need to be entered in Rows 147:186 and Rows 239:278 respectively.

Rebound effect should be entered for each cells for which the change in fuel was entered in Table 1. If it is not done, the cells with missing information will be highlighted in light yellow as illustrated below.

16 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/360044/2014_Background_Documentation_to_DECC_HMT_Supplementary_Appraisal_Guidance.pdf

Box 38 Rebound effects

Unit for rebound: Units of energy — Rebound is expressed in the same energy units as the energy change

Light yellow cells need to be filled up

Traded (EU ETS)	Energy type	Sector		Fuel type	Units	Change in selected units for each year 2014	2015	2016	2017
Traded (EU ETS)	**Electricity**								
Traded (EU ETS)	Electricity	Domestic	-	Electricity	kWh				
Traded (EU ETS)	Electricity	Commercial / Public sector	-	Electricity	kWh	30	25		
Traded (EU ETS)	Electricity	Industry	-	Electricity	kWh				
Traded (EU ETS)	**Gas (used by EU ETS installations)**								
Traded (EU ETS)	Gas (used by EU ETS installations)	Commercial / Public sector	-	Choose gas fuel type	Choose fuel type first				
Traded (EU ETS)	Gas (used by EU ETS installations)	Industry	-	Choose gas fuel type	Choose fuel type first				
Traded (EU ETS)	**Solid fuels (used by EU ETS installations)**								
Traded (EU ETS)	Solid fuels (used by EU ETS installations)	Commercial / Public sector	-	Choose solid fuel type	Choose fuel type first				
Traded (EU ETS)	Solid fuels (used by EU ETS installations)	Industry	-	Choose solid fuel type	Choose fuel type first				

Non-traded	Energy type	Sector		Fuel type	Units	2014	2015	2016	2017
Non-traded	**Gas**								
Non-traded	Gas	Domestic	-	Choose gas fuel type	Choose unit				
Non-traded	Gas	Commercial / Public sector	-	Choose gas fuel type	Choose fuel type first		15		
Non-traded	Gas	Industry	-	Choose gas fuel type	Choose fuel type first				
Non-traded	**Coal**								
Non-traded	Coal	Domestic	-	Choose solid fuel type	Choose fuel type first				
Non-traded	Coal	Commercial / Public sector	-	Choose solid fuel type	Choose fuel type first				
Non-traded	Coal	Industry	-	Choose solid fuel type	Choose fuel type first	30			
Non-traded	**Hydrocarbon oils**								
Non-traded	Hydrocarbon oils	Domestic	-	Choose liquid fuel type	Choose fuel type first	25			
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Choose liquid fuel type	Choose fuel type first	25	23		
Non-traded	Hydrocarbon oils	Industry	-	Choose liquid fuel type	Choose fuel type first				

Transport	Calculated by:	Type of vehicle	Sub-type	Fuel type (if cars)	Units	2014	2015	2016	2017
	By vehicle km								
Transport	**By fuel**			Petrol (average biofuel blend)	litres	15			
Transport	By fuel			Diesel (average biofuel blend)	litres		50		
Transport									
Transport	**By vehicle km**	Choose type of vehicle	Choose main type first	Choose type and subtype first	No data				
Transport	By vehicle km	Choose type of vehicle	Choose main type first	Choose type and subtype first	No data		50		
Transport	By vehicle km	Choose type of vehicle	Choose main type first	Choose type and subtype first	No data	35		25	
Transport	By vehicle km	Choose type of vehicle	Choose main type first	Choose type and subtype first	No data		40		
Transport	By vehicle km	Choose type of vehicle	Choose main type first	Choose type and subtype first	No data				

These data are carried forward into **Calculations-GHG (central, low and high)** for the selected assessment period duration. If information on the size of any direct rebound effects has been entered, the model will value these effects.

- **Emission factors for different energy forms:** Data on emission factors will be extracted from DECC's toolkit. These will supplemented with additional emission factors (e.g.kg CO_2e/km) extracted from Defra Greenhouse Gas Conversion Factor Repository[17].

Table 7.2 Summary of emission factors used

Emission factor	Units	Comment	Sources
Electricity emissions factors	kgCO_2e/kWh	For policy appraisal the model uses (long run) marginal grid electricity emissions factors.	DECC modelling https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
Average emission factors in each sector (e.g. domestic, non-domestic, commercial) for solid fuels and oil products	kgCO_2e /KWh	These are based on the mix of fuels per sector reported in DUKES. Recommended when policy does not target specific solid fuels or oil products or specific non-domestic sectors.	DECC Digest of UK energy statistics (DUKES) https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes
Gaseous, liquid and solid fuels emissions factors	kgCO_2e per unit (tonnes, kWh, Litres, Therms)	For direct fuel use average emissions factors are used (i.e. identical to marginal)	Defra Greenhouse Gas Conversion Factor Repository http://www.ukconversionfactorscarbonsmart.co.uk/

[17] http://www.ukconversionfactorscarbonsmart.co.uk/

Emission factor	Units	Comment	Sources
Transport fuel emissions factors	kgCO_2e/litre, kg CO_2e/km kg CO_2e/ passenger.km	To prepare conversion factors for transport fuel	Department for Transport (for road and rail fuels expressed in litres) Defra Greenhouse Gas Conversion Factor Repository (distance activity data) http://www.ukconversionfactorscarbonsmart.co.uk/
Fuel properties	GJ/tonnes	To prepare conversion factors for fuel	Defra, DECC, Ricardo-AEA, CarbonSmart, 2014. Greenhouse Gas Conversion Factor Repository http://www.ukconversionfactorscarbonsmart.co.uk/
Conversion factors from user input units to kWh for selected fuels (2014)	kWh/tonnes, kWh/litres, kWh/m^3	These provide conversion factors based on fuel properties and carbon emission factors.	Derived from publicly available sources (i.e. desktop search)
Conversion factors from user input units to litres of fuel for transport (kWh in the case of electric transport) (2014) and units after conversion	kWh/km, kWh/miles kWh/passenger km	These provide conversion factors based on transportation type and carbon emission factors.	Derived from publicly available sources (i.e. desktop search)
Carbon prices and sensitivities (low, central and high) for appraisal	£/tCO2e	To value changes in emissions occurring in traded and non-traded sectors	Carbon prices for different price scenarios can be extracted from supporting table 3 of DECC's toolkit and from the following website: https://www.gov.uk/government/collections/carbon-valuation--2
Long-run variable costs of energy supply (LRVCs)	p/kWh	To monetise change in energy use	Supporting tables 9-13 of DECC's toolkit.
Retail energy prices	p/kWh	To monetise direct rebound effects	Supporting tables 4-8 of DECC's toolkit.

- **Carbon prices and sensitivities (low, central and high) for appraisal (£/tCO_2e):** the model uses the Traded Price of Carbon (TPC) to value changes in emissions which occur in the traded sector (i.e. sectors covered by the European Trading Scheme) and the Non-Traded Price of Carbon (NTPC) for those that are not traded.
- **Long-run variable costs of energy supply (LRVCs)** to monetise the change in energy use. Variable supply costs should be specific for different energy types and end-users (industrial, commercial and residential). Units will depend on the form of energy measured (e.g. p/kWh or p/litre). LRVCs for different cost scenarios are extracted from supporting tables 9-13 of DECC's toolkit.
- **Retail fuel prices** to monetise direct rebound effects when these are available. As indicated in DECC's guidance, retail prices capture the welfare benefit directly related to the policy or project (i.e. acting as a proxy for the consumer's willingness-to pay an increase in consumption of the main energy service in question). Retail fuel prices are specific for different energy types and end-users (industrial, commercial and residential). Units depend on the form of energy measured (e.g. p/kWh or p/litre). Retail fuel prices for different price scenarios are extracted from supporting tables 4-8 of DECC's toolkit.

7.3 Calculations

Calculations are undertaken in the **Calculation-GHG (central, low and high)**. Depending on the inputs provided by the user, specifically the type of fuels selected in the input, the model will monetise either GHG impacts only, or

GHG and energy impacts combined. This is because data on future energy price projections is only available for some fuels. Table below presents details of what type of assessment is undertaken for which fuels.

Table 7.3 Scope of the assessment for various fuels

	Fuels covered
Monetisation of the GHG impacts (carbon valuation)	All available fuels, vehicles and units
Monetisation of the GHG impacts and energy impacts	Fuels: Natural gas Burning oil Gas oil Coal (domestic) Coal (industrial) Petrol (average biofuel blend) Diesel (average biofuel blend) Vehicles: Cars: All sizes – Fuels: Petrol, diesel, hybrid and electric. Motorbikes: All sizes – Petrol Taxis: Black cabs – Diesel Local bus (not London) – Diesel Local London bus – Diesel Average local bus – Diesel Coach – Diesel Light rail and tram – Electricity London Underground – Electricity

The assessment method is comprised of the following steps:

- **Step 1: Quantify net changes in GHG emissions by applying fuel**

Quantification of GHG is conducted by applying fuel- specific emissions factors to the net energy changes inserted by the user. Emission factors based on vehicle km are also applied where relevant. At this stage the model provides the total net change in GHG emissions, broken down by traded and non-traded sectors. The user needs to input any quantified net changes in GHG emissions that result from non-energy sources. These have to be allocated to the traded or non-traded sector in order to conduct the valuation.

Box 39 Quantify net changes in GHG emissions by applying fuel

Change in energy consumption and in non-fuel emissions are imported from **Calculations-GHG (central, low and high)** (rows 7:40)

Emission factors are imported from **Calculations-GHG (central, low and high)** (rows 74-101)

Step inputs:

Input	Units
Change in energy consumption	Variable
CO2 emission factors	Variable

Step outputs:

Output	Units
Change in CO2 emissions from each sector / fuel	tCO2e

Calculations:

						Change in tonnes of CO2 equivalent				
Electricity (Traded)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**User input unit**	**2014**	**2015**	**2016**	**2017**	**20**
Traded	Electricity	Domestic	-	Electricity	kWh	-	-	-	-	
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	0.01	0.00	-	-	
Traded	Electricity	Industry	-	Electricity	kWh	-	-	-	-	
Fossil fuels (Traded / Non-traded)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**	**20**
Traded	Gas (used by EU ETS installatic	Commercial / Public sector	-	Choose gas fuel type	Choose fuel type first	-	-	-	-	
Traded	Gas (used by EU ETS installatic	Industry	-	Choose gas fuel type	Choose fuel type first	-	-	-	-	
Traded	Solid fuels (used by EU ETS ins	Commercial / Public sector	-	Average commercial .	kWh	-	-	-	-	
Traded	Solid fuels (used by EU ETS ins	Industry	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-	
Non-traded	Gas	Domestic	-	Choose gas fuel type	Choose unit	-	-	-	-	
Non-traded	Gas	Commercial / Public sector	-	Natural gas	cubic metres	40.69	65.11	-	-	
Non-traded	Gas	Industry	-	Choose gas fuel type	Choose fuel type first	-	-	-	-	
Non-traded	Coal	Domestic	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-	
Non-traded	Coal	Commercial / Public sector	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-	
Non-traded	Coal	Industry	-	Coal (industrial)	tonnes	28,279.46	47,132.44	-	-	
Non-traded	Hydrocarbon oils	Domestic	-	Petrol (average biofu	kWh	116.39	-	-	-	
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Diesel (average biofu	tonnes	15,587.00	162,104.80	-	-	
Non-traded	Hydrocarbon oils	Industry	-	Choose liquid fuel typ	Choose fuel type first	-	-	-	-	
Transport (by fuel)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**	**20**
Transport	By fuel	-	-	Petrol (average biofu	litres	118.34	-	-	-	
Transport	By fuel	-	-	Diesel (average biofu	litres	-	145.73	-	-	
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**	**20**
Transport	By vehicle km	Rail	Light rail and tram	Electricity	passenger.km	-	0.74	-	-	
Transport	By vehicle km	Cars	Average car	Unknown	veh km	-	6.06	-	-	
Transport	By vehicle km	Cars	Average car	Electric	veh miles	-	-	-	-	
Transport	By vehicle km	Motorbike	Small motorbike	Petrol	veh miles	-	7.62	-	-	
Transport	By vehicle km	Bus	Local London bus	Diesel	passenger.km	-	-	-	-	
Non-fuel emissions	**Traded / Non-traded**				**Units**	**2014**	**2015**	**2016**	**2017**	**20**
Non-fuel emissions	Traded				tCO2e	-	6,000.00	-	-	
Non-fuel emissions	Non-traded				tCO2e	-	5,000.00	-	-	

These data are carried forward to:

- Calculations-GHG (central, low and high) (row 283:312) for monetisation of the net changes in GHG emissions (traded and non-traded)

- Calculations-GHG (central, low and high) (rows 411:455) for calculation of monetisation of energy change, and

- Results-GHG (rows 9:26) for the Net carbon emissions in ktonnes CO_2e

- Steps 2: Monetise the net changes in GHG emissions

This allows the following carbon prices (expressed as £/tCO_2e) to be applied as total quantified changes in emissions (Mt CO_2e):

- To the traded sector the Traded Price of Carbon (TPC).
- To the non-traded sector the Non-Traded Price of Carbon (NTPC).

Carbon prices distinguish between traded and non-traded emissions as well as 3 price scenarios. Monetary results are then discounted following Green Book guidance.

Box 40 Monetise the net changes in GHG emissions

Quantified net changes in GHG emissions are imported from **Calculations-GHG (central, low and high)** (rows 234:263)

Emission factors are imported from **Calculations-GHG (central, low and high)** (rows 74-101)

Carbon price are imported from **Calculations-GHG (central, low and high)** (rows 106:113)

Step inputs:

Input	Units
Change in CO2 emissions from each sector / fuel	tCO2e
Carbon prices and sensitivities (low, central and high) f	2014 £/tCO2e

Step outputs:

Output	Units
Monetised value of change in carbon emissions	£ 2014

Calculations:

						Monetised value of change in carbon emissions			
Electricity (Traded)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**User input unit**	**2014**	**2015**	**2016**	**2017**
Traded	Electricity	Domestic	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	0.00	0.00	-	-
Traded	Electricity	Industry	-	Electricity	kWh	-	-	-	-
Fossil fuels (Traded / Non-traded)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**
Traded	Gas (used by EU ETS installatic	Commercial / Public sector	-	Choose gas fuel type	Choose fuel type first	-	-	-	-
Traded	Gas (used by EU ETS installatic	Industry	-	Choose gas fuel type	Choose fuel type first	-	-	-	-
Traded	Solid fuels (used by EU ETS ins	Commercial / Public sector	-	Average commercial	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS ins	Industry	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-
Non-traded	Gas	Domestic	-	Choose gas fuel type	Choose unit	-	-	-	-
Non-traded	Gas	Commercial / Public sector	-	Natural gas	cubic metres	24.77	40.23	-	-
Non-traded	Gas	Industry	-	Choose gas fuel type	Choose fuel type first	-	-	-	-
Non-traded	Coal	Domestic	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-
Non-traded	Coal	Commercial / Public sector	-	Choose solid fuel typ	Choose fuel type first	-	-	-	-
Non-traded	Coal	Industry	-	Coal (industrial)	tonnes	17,216.54	29,124.64	-	-
Non-traded	Hydrocarbon oils	Domestic	-	Petrol (average biofu	kWh	70.86	-	-	-
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Diesel (average biofu	tonnes	9,489.37	100,169.74	-	-
Non-traded	Hydrocarbon oils	Industry	-	Choose liquid fuel typ	Choose fuel type first	-	-	-	-
Transport (by fuel)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**
Transport	By fuel	-	-	Petrol (average biofu	litres	72.04	-	-	-
Transport	By fuel	-	-	Diesel (average biofu	litres	-	90.05	-	-
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**EF Units**	**2014**	**2015**	**2016**	**2017**
Transport	By vehicle km	Rail	Light rail and tram	Electricity	passenger.km	-	0.46	-	-
Transport	By vehicle km	Cars	Average car	Unknown	veh km	-	3.75	-	-
Transport	By vehicle km	Cars	Average car	Electric	veh miles	-	-	-	-
Transport	By vehicle km	Motorbike	Small motorbike	Petrol	veh miles	-	4.71	-	-
Transport	By vehicle km	Bus	Local London bus	Diesel	passenger.km	-	-	-	-
Non-fuel emissions	**Traded / Non-traded**				**Units**	**2014**	**2015**	**2016**	**2017**
Non-fuel emissions	Traded				tCO2e	-	273.46	-	-
Non-fuel emissions	Non-traded				tCO2e	-	3,089.66	-	-

These data are carried forward to **Calculations-GHG (central, low and high)** (row 528:556) for the calculation of the discounted and deflated monetised value of GHG emissions.

▶ Steps 3 & 4: Conversion of energy change and rebound effects from input units to kWh or litres

Given the range of units that can be provided, by converting the energy change or rebound effects inputted by the user, this allows provision of the appropriate unit since future energy price projections are either issued in kWh for electricity, gas and coal or litres for liquid fuels.

Box 41 Conversion of energy change and rebound effects from input units to kWh or litres

Energy change:

The calculation of the energy change are imported from the following sheet:

- Change in energy consumption and in non-fuel emissions are imported from **Calculations-GHG (central, low and high)** (rows 7:40)
- Conversion factors for energy change are imported from **Calculations-GHG (central, low and high)** (rows 117-144)

Box 41 Conversion of energy change and rebound effects from input units to kWh or litres

Step inputs:

Input	Units
Change in energy consumption	Variable
Conversion factors	Variable

Step outputs:

Output	Units
Converted change in energy consumption	kWh or litres of fuel as appropriate

Calculations:

						Converted change in energy consumption (kWh o			
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**	**2014**	**2015**	**2016**	**2017**
Traded	Electricity	Domestic	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Industry	-	Electricity	kWh	-	-	-	-
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	kWh	-	-	-	-
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Gas	Domestic	-	Natural gas	kWh	-	236,100,000	236,100,000	236,100,000
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	kWh	-	-	-	-
Non-traded	Gas	Industry	-	LNG	kWh	-	-	-	-
Non-traded	Coal	Domestic	-	Coal (domestic)	kWh	-	- 236,099,189	- 236,099,189	- 236,099,189
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Non-traded	Coal	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	litres	-	-	-	-
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Transport	By fuel	-	-	Diesel (average biofue	litres	-	-	-	-
Transport	By fuel	-	-	Aviation spirit	litres	-	-	-	-
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**Converted unit (kWh or litres of)**				
Transport	By vehicle km	Cars	Average car	Petrol	Petrol (average biofue	-	- 175,813,788	- 175,813,788	- 175,813,788
Transport	By vehicle km	Cars	Average car	Diesel	Diesel (average biofue	-	- 63,625,380	- 63,625,380	- 63,625,380
Transport	By vehicle km	Cars	Average car	CNG	-	-	-	-	-
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	-	-	-	-
Transport	By vehicle km	Cars	Average car	Electric	kWh	-	-	-	-

These data are carried forward to **Calculations-GHG (central, low and high)** (row 427:453) for the monetisation of energy change (rows 427:453) and rebound effects (rows 380:406)

Rebound effects:

The calculation of the rebound effects are imported from the following sheet:

- **Calculations-GHG (central, low and high)** rebound effects from rows 43:70
- **Calculations-GHG (central, low and high)** Conversion factors from user input units to kWh or litres from rows 117:144
- **Calculations-GHG (central, low and high)** Step 3: Conversion of energy change from input units to kWh or litres from rows 333:359

Calculations:

						Converted rebound effects (kWh or litres of fu			
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**	**2014**	**2015**	**2016**	**2017**
Traded	Electricity	Domestic	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Industry	-	Electricity	kWh	-	-	-	-
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	kWh	-	-	-	-
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Gas	Domestic	-	Natural gas	kWh	-	- 12,426,316	- 12,426,316	- 12,426,316
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	kWh	-	-	-	-
Non-traded	Gas	Industry	-	LNG	kWh	-	-	-	-
Non-traded	Coal	Domestic	-	Coal (domestic)	kWh	-	26,233,243	26,233,243	26,233,243
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Non-traded	Coal	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	litres	-	-	-	-
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Transport	By fuel	-	-	Diesel (average biofue	litres	-	-	-	-
Transport	By fuel	-	-	Aviation spirit	litres	-	-	-	-
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**Converted unit (kWh or litres of)**				
Transport	By vehicle km	Cars	Average car	Petrol	Petrol (average biofue	-	9,253,357	9,253,357	9,253,357
Transport	By vehicle km	Cars	Average car	Diesel	Diesel (average biofue	-	3,348,704	3,348,704	3,348,704
Transport	By vehicle km	Cars	Average car	CNG	-	-	-	-	-
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	-	-	-	-
Transport	By vehicle km	Cars	Average car	Electric	kWh	-	-	-	-

These data are carried forward to **Calculations-GHG (central, low and high)** rows 427:453 for Step 6. Monetisation of rebound effects.

▶ Steps 5 : Monetise the net changes in energy use of a policy

Specific emissions factors to the net energy changes are inserted by the user. These are then monetise by applying the long-run variable costs of energy supply (LRVCs)

Box 42 Monetise the net changes in energy use of a policy

The net changes in energy use of a policy are monetised by

- **Calculations-GHG (central, low and high)** Long-run variable costs of energy supply from rows 148:175
- **Calculations-GHG (central, low and high)** Retail energy prices from rows 179:206
- **Calculations-GHG (central, low and high)** Step 3: Conversion of energy change from input units to kWh or litres from rows 333:359

Calculations:

						Cost of energy change (£ 2014)			
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**	**2014**	**2015**	**2016**	**2017**
Traded	Electricity	Domestic	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	-	-	-	-
Traded	Electricity	Industry	-	Electricity	kWh	-	-	-	-
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	kWh	-	-	-	-
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Gas	Domestic	-	Natural gas	kWh	-	5,418,279	5,590,154	5,429,535
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	kWh	-	-	-	-
Non-traded	Gas	Industry	-	LNG	kWh	-	-	-	-
Non-traded	Coal	Domestic	-	Coal (domestic)	kWh	-	- 11,305,781	- 11,403,156	- 11,498,460
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-
Non-traded	Coal	Industry	-	Coal (industrial)	kWh	-	-	-	-
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	litres	-	-	-	-
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	litres	-	-	-	-
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Transport	By fuel	-	-	Diesel (average biofue	litres	-	-	-	-
Transport	By fuel	-	-	Aviation spirit	litres	-	-	-	-
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**Converted unit (kWh or litres of)**				
Transport	By vehicle km	Cars	Average car	Petrol	Petrol (average biofue	-	- 80,363,665	- 77,583,378	- 76,728,690
Transport	By vehicle km	Cars	Average car	Diesel	Diesel (average biofue	-	- 32,311,267	- 31,156,344	- 30,800,984
Transport	By vehicle km	Cars	Average car	CNG	-	-	-	-	-
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	-	-	-	-
Transport	By vehicle km	Cars	Average car	Electric	kWh	-	-	-	-

These data are carried forward to **Calculations-GHG (central, low and high)** (row 573:599) step 8 for the calculation of the discounted and deflated monetised value of change in energy consumption.

Steps 6: Monetise the net changes in the direct rebound effects of a policy

The following is applied (expressed as price/kWh or price/litre):

- Long-run variable costs of energy supply (LRVCs) to monetise changes in energy use
- Retail fuel prices to monetise direct rebound effects (e.g. comfort taking).

Monetary results can then be discounted following the Green Book guidance.

Box 43 Monetise the net changes in the direct rebound effects of a policy

The net changes in energy use of a policy are monetised by

- **Calculations-GHG (central, low and high)** Long-run variable costs of energy supply from rows 148:175
- **Calculations-GHG (central, low and high)** Retail energy prices from rows 179:206
- **Calculations-GHG (central, low and high)** Step 4: Conversion of rebound effects from input units to kWh or litres from rows 380:406

Box 43 Monetise the net changes in the direct rebound effects of a policy

Step inputs:

Input	Units
Converted rebound effects	kWh or litres of fuel as appropriate
Long-run variable costs of energy supply (LRVCs)	Variable

Step outputs:

Output	Units
Cost of rebound effects	£ 2014

Calculations:

						Cost of rebound effects (£ 2014)			
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**	**2014**	**2015**	**2016**	**2017**
Traded	Electricity	Domestic	-	Electricity	kWh	0	0	0	0
Traded	Electricity	Commercial / Public sector	-	Electricity	kWh	0	0	0	0
Traded	Electricity	Industry	-	Electricity	kWh	0	0	0	0
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	kWh	0	0	0	0
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	kWh	0	0	0	0
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	kWh	0	0	0	0
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	kWh	0	0	0	0
Non-traded	Gas	Domestic	-	Natural gas	kWh	0	-582924	-624692	-648998
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	kWh	0	0	0	0
Non-traded	Gas	Industry	-	LNG	kWh	0	0	0	0
Non-traded	Coal	Domestic	-	Coal (domestic)	kWh	0	1326728	1337547	1348136
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	kWh	0	0	0	0
Non-traded	Coal	Industry	-	Coal (industrial)	kWh	0	0	0	0
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	litres	0	0	0	0
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	litres	0	0	0	0
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	litres	0	0	0	0
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Converted unit**				
Transport	By fuel	-	-	Diesel (average biofue	litres	0	0	0	0
Transport	By fuel	-	-	Aviation spirit	litres	0	0	0	0
Transport (by veh km)	**Energy type**	**Sector**	**Vehicle subtype (if applicable)**	**Fuel type**	**Converted unit (kWh or litres of)**				
Transport	By vehicle km	Cars	Average car	Petrol	Petrol (average biofue	0	11791690	11679127	11716040
Transport	By vehicle km	Cars	Average car	Diesel	Diesel (average biofue	0	4490010	4439856	4450316
Transport	By vehicle km	Cars	Average car	CNG	-	0	0	0	0
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	0	0	0	0
Transport	By vehicle km	Cars	Average car	Electric	kWh	0	0	0	0

These data are carried forward to **Calculations-GHG (central, low and high)** (row 618:644) step 9 for the calculation of discounted and deflated monetised value of rebound effects.

Steps 7: Discount and deflate monetised value of GHG emissions

For the net changes in GHG emissions for traded and non-traded sectors, these are monetised (refer to step 2 above where carbon prices are applied to the total quantified changes in emissions) and discounted for the selected number of years.

Box 44 Discount and deflate monetised value of GHG emissions

The monetised value of GHG emissions are discounted and deflated by:

- **Calculations-GHG (central, low and high)** Common inputs – GDP deflator in rows 213:214
- **Calculations-GHG (central, low and high)** Step 2: Monetisation of the net changes in GHG emissions (traded and non-traded) from rows 283:312

The discounted cost is calculated for each year of the assessment. The reference year is picked up from the **Control** (cell C12). The years for which discount factors are calculated are presented in **Calculations-GHG (central, low and high)** rows 525. The GDP deflators used for the inflation adjustment are presented in **Calculations-GHG (central, low and high)** (rows 515:516) for:

- The year to which the costs / benefits should be inflated / deflated (see GDP deflator feeding from **Control**, cell C15)

An INDEX-MATCH function is used in cells I213:J214 to feed in the low, high uncertainty GDP deflator values from **Inputs-Common data** (rows 11:46) for the years specified in column B.

Uncertainty is carried through the calculations. This is done using two parallel systems:

- Calculations are done for the three uncertainty scenarios (low, central and high) as provided by the user.
- A qualitative scoring system considers the uncertainty of fixed inputs (and the user inputs if no low and high values are entered).

Box 44 Discount and deflate monetised value of GHG emissions

Calculations:

						2014	2015	2016	2017	2018	20
					Discount factor	1.00	1.00	0.97	0.93	0.90	0.8
						Discounted value of GHG emissions (£ (2014 prices))					
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Traded	Electricity	Domestic	-	Electricity	0	-	-	-	-	-	-
Traded	Electricity	Commercial / Public sector	-	Electricity	0	-	-	-	-	-	-
Traded	Electricity	Industry	-	Electricity	0	-	-	-	-	-	-
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**						
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	0	-	-	-	-	-	-
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	0	-	-	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	0	-	-	-	-	-	-
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	Converted unit	-	-	-	-	-	-
Non-traded	Gas	Domestic	-	Natural gas	kWh	-	-	-	-	-	-
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	kWh	-	-	-	-	-	-
Non-traded	Gas	Industry	-	LNG	kWh	-	-	-	-	-	-
Non-traded	Coal	Domestic	-	Coal (domestic)	Converted unit	-	-	-	-	-	-
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	kWh	-	-	-	-	-	-
Non-traded	Coal	Industry	-	Coal (industrial)	kWh	-	-	-	-	-	-
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	kWh	-	-	-	-	-	-
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	kWh	-	-	-	-	-	-
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	kWh	-	-	-	-	-	-
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**kWh**						
Transport	By fuel	-	-	Diesel (average biofue	kWh	-	5.73	5.62	5.51	5.41	5.
Transport	By fuel	-	-	Aviation spirit	kWh	-	-	-	-	-	-
Transport (by veh km)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**kWh**						
Transport	By vehicle km	Cars	Average car	Petrol	kWh	-	5.99	5.87	5.76	5.65	5.
Transport	By vehicle km	Motorbike	Average motorbike	Petrol	litres	-	-	-	-	-	-
Transport	By vehicle km	Cars	Average car	CNG	litres	-	-	-	-	-	-
Transport	By vehicle km	Rail	London Underground	Electricity	litres	-	-	-	-	-	-
Transport	By vehicle km	Cars	Average car	Electric	Converted unit	-	-	-	-	-	-

Step qualitative uncertainty score: 15

These data are carried forward to **Results-GHG** (rows 31:48) for the Discounted monetised value of carbon emissions.

Steps 8: Discount and deflate monetised value of change in energy consumption

Following the conversion of energy change inputs into a consistent format in step 3. The net changes in energy use of a policy are monetised by applying the long-run variable cost of energy supply. These values are then discounted in this step for the selected number of years.

Box 45 Discount and deflate monetised value of change in energy consumption

The net change in energy consumption are discounted and deflated by:

- **Calculations-GHG (central, low and high)** Common inputs – GDP deflator in rows 213:214
- **Calculations-GHG (central, low and high)** Step 5: Monetisation of energy change from rows 426:453

The discounted cost is calculated for each year of the assessment. The reference year is picked up from the **Control** (cell C12). The years for which discount factors are calculated are presented in **Calculations-GHG (central, low and high)** rows 525. The GDP deflators used for the inflation adjustment are presented in **Calculations-GHG (central, low and high)** (rows 515:516) for:

- The year to which the costs / benefits should be inflated / deflated (see GDP deflator feeding from **Control**, cell C15)

An INDEX-MATCH function is used in cells I213:J214 to feed in the low, high uncertainty GDP deflator values from **Inputs-Common data** (rows 11:46) for the years specified in column B.

Uncertainty is carried through the calculations. This is done using two parallel systems:

- Calculations are done for the three uncertainty scenarios (low, medium and high) as provided by the user.
- A qualitative scoring system considers the uncertainty of fixed inputs (and the user inputs if no low and high values are entered).

Box 45 Discount and deflate monetised value of change in energy consumption

Step inputs:

Input	Units
Cost of energy change	£ 2014

Step outputs:

Output	Units
Discounted value of energy consumption	£ (2014 prices)

Output units: £k (2014 prices)

Calculations:

						Discounted value of energy consumption (£ (2014 price					
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**	**2014**	**2015**	**2016**	**2017**	**2018**	**20**
Traded	Electricity	Domestic	-	Electricity	0	0.61	0.67	0.70	0.69	0.69	
Traded	Electricity	Commercial / Public sector	-	Electricity	0	-	-	-	-	-	
Traded	Electricity	Industry	-	Electricity	0	-	-	-	-	-	
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**Discount factor**						
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	0	-	-	-	-	-	
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	0	-	-	-	-	-	
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	0	-	-	-	-	-	
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	0	-	-	-	-	-	
Non-traded	Gas	Domestic	-	Natural gas	0	-	-	-	-	-	
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	0	-	-	-	-	-	
Non-traded	Gas	Industry	-	LNG	0	-	-	-	-	-	
Non-traded	Coal	Domestic	-	Coal (domestic)	0	-	-	-	-	-	
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	0	-	-	-	-	-	
Non-traded	Coal	Industry	-	Coal (industrial)	0	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	Converted unit	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	kWh	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	kWh	-	-	-	-	-	
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**kWh**						
Transport	By fuel	-	-	Diesel (average biofue	Converted unit	-	33.82	32.45	31.11	29.81	
Transport	By fuel	-	-	Aviation spirit	kWh	-	-	-	-	-	
Transport (by veh km)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**kWh**						
Transport	By vehicle km	Cars	Average car	Petrol	kWh	-	37.86	36.34	34.84	33.40	
Transport	By vehicle km	Motorbike	Average motorbike	Petrol	kWh	-	-	-	-	-	
Transport	By vehicle km	Cars	Average car	CNG	kWh	-	-	-	-	-	
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	-	-	-	-	-	
Transport	By vehicle km	Cars	Average car	Electric	kWh	-	-	-	-	-	

These data are carried forward to **Results-GHG** (rows 56:67) for the discounted monetised value of change in energy consumption

▶ Steps 9: Discount and deflate monetised value of rebound effects

In this step the monetised value of rebound effects from projected retail energy prices are calculated in step 6 above is discounted for the selected number of years.

Box 46 Discount and deflate monetised value of rebound effects

The monetised value of rebound effects are discounted and deflated by:

- **Calculations-GHG (central, low and high)** Common inputs – GDP deflator in rows 213:214
- **Calculations-GHG (central, low and high)** Step 6: Monetisation of rebound effects from rows 474:500

The discounted cost is calculated for each year of the assessment. The reference year is picked up from the **Control** (cell C12). The years for which discount factors are calculated are presented in **Calculations-GHG (central, low and high)** rows 525. The GDP deflators used for the inflation adjustment are presented in **Calculations-GHG (central, low and high)** (rows 515:516) for:

- The year to which the costs / benefits should be inflated / deflated (see GDP deflator feeding from **Control**, cell C15)

An INDEX-MATCH function is used in cells I213:J214 to feed in the low, high uncertainty GDP deflator values from **Inputs-Common data** (rows 11:46) for the years specified in column B.

Uncertainty is carried through the calculations. This is done using two parallel systems:

- Calculations are done for the three uncertainty scenarios (low, medium and high) as provided by the user.
- A qualitative scoring system considers the uncertainty of fixed inputs (and the user inputs if no low and high values are entered).

Box 46 Discount and deflate monetised value of rebound effects

Step inputs:

Input	Units
Cost of rebound effects	£ 2014

Step outputs:

Output	Units
Discounted value of rebound effects	£ (2014 prices)

Output units: £k (2014 prices)

Calculations:

						Discounted value of rebound effects (£ (2014 prices))					
Electricity (Traded)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**	**2014**	**2015**	**2016**	**2017**	**2018**	**201**
Traded	Electricity	Domestic	-	Electricity	0	-	-	-	-	-	
Traded	Electricity	Commercial / Public sector	-	Electricity	0	-	-	-	-	-	
Traded	Electricity	Industry	-	Electricity	0	-	-	-	-	-	
Fossil fuels (Traded / Non-	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**						
Traded	Gas (used by EU ETS installatio	Commercial / Public sector	-	Natural gas	0	-	-	-	-	-	
Traded	Gas (used by EU ETS installatio	Industry	-	Natural gas	0	-	-	-	-	-	
Traded	Solid fuels (used by EU ETS inst	Commercial / Public sector	-	Coal (domestic)	0	-	-	-	-	-	
Traded	Solid fuels (used by EU ETS inst	Industry	-	Coal (industrial)	0	-	-	-	-	-	
Non-traded	Gas	Domestic	-	Natural gas	0	-	-	-	-	-	
Non-traded	Gas	Commercial / Public sector	-	Other petroleum gas	0	-	-	-	-	-	
Non-traded	Gas	Industry	-	LNG	Discount factor	-	-	-	-	-	
Non-traded	Coal	Domestic	-	Coal (domestic)	0	-	-	-	-	-	
Non-traded	Coal	Commercial / Public sector	-	Coal (domestic)	0	-	-	-	-	-	
Non-traded	Coal	Industry	-	Coal (industrial)	0	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Domestic	-	Diesel (average biofue	0	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Commercial / Public sector	-	Petrol (average biofue	0	-	-	-	-	-	
Non-traded	Hydrocarbon oils	Industry	-	Naphtha	0	-	-	-	-	-	
Transport (by fuel)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**						
Transport	By fuel	-	-	Diesel (average biofue	0	-	- 4.88	- 4.73	- 4.59	- 4.45	-
Transport	By fuel	-	-	Aviation spirit	0	-	-	-	-	-	
Transport (by veh km)	**Energy type**	**Sector**	**applicable)**	**Fuel type**	**0**						
Transport	By vehicle km	Cars	Average car	Petrol	Converted unit	-	- 12.18	- 11.80	- 11.46	- 11.14	-
Transport	By vehicle km	Motorbike	Average motorbike	Petrol	kWh	-	-	-	-	-	
Transport	By vehicle km	Cars	Average car	CNG	kWh	-	-	-	-	-	
Transport	By vehicle km	Rail	London Underground	Electricity	kWh	-	-	-	-	-	
Transport	By vehicle km	Cars	Average car	Electric	Converted unit	-	-	-	-	-	

These data are carried forward to **Results-GHG** (rows 72:88) for the discounted and deflated monetised value of rebound effects.

7.4 Results-GHG and results-summary

The assessment conducted provides the following outputs (in **Results-GHG**):

- Net change in quantity of GHG emissions (Mt CO_2e) for traded and non-traded sector;
- Net change in GHG emissions (£) for traded and non-traded sector;
- Net change in energy use (£) for traded and non-traded sector;
- Total other benefits resulting from primary rebound effects (£);and
- Discount cost over appraisal period and quantified net present value (£).

Changes associated with GHG emissions and monetised net changes to GHG emissions, energy use, and rebound effect are calculated in these tables listed above respectively over a selected number of years. The NPV (which could be annualised) includes the valuation of the changes in traded and non-traded GHG emissions. This value provides a good indication on whether a measure is good value-for-money; positive NPV would be indicative of a net benefit, and the negative NPV of a net loss.

Valid conclusions on whether a measure leads to a net change in emissions or provides good-value for money need to be based on the full appraisal of energy and emission changes, including those emissions that result from non-fuels. Therefore, when valuing the outputs the user should critically assess the significance of any changes that have not been consider within the model.

Box 47 Results- GHG and Results-Summary

Results-GHG sheet presents net change of GHG emissions in ktonnes of CO_2e and discounted monetised net change over the selected appraisal years and for the different uncertainty scenarios.

Net change in quantity of GHG emissions (kt CO2e) for traded and non-traded sector (rows 9:28)

The first table in the **Results-GHG** sheet presents quantified net changes in GHG emissions in terms of ktonnes CO_2e for traded, non-traded, transport and non-fuel emissions sectors as result of implementing the policy. The results presented are fed from:

- **Calculations-GHG (central, low and high) -** Step 1: Quantify net changes in GHG emissions by applying fuel (rows 219:265)
- **Control** sheet – cell C13 and 14

Net carbon emissions in ktonnes CO_2e

(minus indicates an emissions saving)

Units: thousand tonnes		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	Central						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00
	Low						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00
	High						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00
Non-fuel emissions	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CO2e	Central						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00
	Low						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00
	High						0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00	0.00	0.00	0.00

The qualitative uncertainty score is shown in **Results-GHG** row 28.

To calculate the discounted net changes, the measure start and end assessment year is picked up from cells C13 and C14. The multiple IF functions are used to calculate the correct discount factor. For the start year and all years before the start year, the discount factor is 1. For the years beyond the start year rate, the discount factor is calculated according to the equation presented in Box 3 above, using the discount rate from **Control**, cell C35

An INDEX MATCH function is used to pick up appropriate discount factor from **Calculations-GHG (central, low and high)** (row 525) for each year. The discount factor is then multiplied by the undiscounted GHG cost calculated for each scenarios in **Calculations-GHG (central, low and high)** rows 525:551.

This calculation is conducted for the "Net change in GHG emissions (£) for traded and non-traded sector"; "Net change in energy use (£) for traded and non-traded sector" and "Total other benefits resulting from primary rebound effects (£)" as shown in the next three table examples below.

Net change in GHG emissions (£) for traded and non-traded sector (rows 31:50)

The discounted cost of GHG emissions is fed from **Calculations-GHG (central, low and high)** rows 529:554 for each year of the assessment.

Discounted monetised value of carbon emissions

(minus indicates benefits)

Units: £k (2014 prices)		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Traded	Central						0.01	0.03	0.04	0.05	0.06	0.06	0.07	0.07	0.07	0.06	0.06
	Low						0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	High						0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.11	0.10	0.09
Non-traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	Central						21.27	20.89	20.51	20.14	19.77	19.40	0.00	0.00	0.00	0.00	0.00
	Low						10.63	10.45	10.26	10.07	9.88	9.70	0.00	0.00	0.00	0.00	0.00
	High						31.90	31.34	30.77	30.21	29.65	29.10	0.00	0.00	0.00	0.00	0.00
Non-fuel emissions	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CO2e	Central						21.28	20.92	20.56	20.19	19.83	19.46	0.07	0.07	0.07	0.06	0.06
	Low						10.63	10.45	10.27	10.09	9.91	9.73	0.03	0.03	0.03	0.03	0.03
	High						32.00	31.44	30.89	30.33	29.77	29.22	0.12	0.12	0.11	0.10	0.09

The qualitative uncertainty score is shown in **Results-GHG** row 50.

Net change in energy use (£) for traded and non-traded sector (rows 53:69)

The discounted cost of GHG emissions is fed from **Calculations-GHG (central, low and high)** rows 574:599 for each year of the assessment.

Box 47 Results- GHG and Results-Summary

Discounted monetised value of change in energy consumption

(minus indicates benefits)

Units: £k (2014 prices)		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Traded	Central						0.84	0.85	0.84	0.85	0.85	0.86	0.86	0.82	0.79	0.78	0.76
	Low						0.76	0.78	0.76	0.77	0.78	0.79	0.79	0.77	0.75	0.74	0.71
	High						1.00	1.00	0.97	0.95	0.95	0.93	0.92	0.89	0.86	0.85	0.85
Non-traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	Central						64.42	63.48	62.58	61.67	60.75	59.87	0.00	0.00	0.00	0.00	0.00
	Low						58.14	55.78	53.52	51.29	49.20	47.19	0.00	0.00	0.00	0.00	0.00
	High						88.03	86.79	85.54	84.27	83.09	81.90	0.00	0.00	0.00	0.00	0.00
Total	Central						65.26	64.33	63.42	62.52	61.60	60.73	0.86	0.82	0.79	0.78	0.76
	Low						58.90	56.56	54.28	52.05	49.98	47.98	0.79	0.77	0.75	0.74	0.71
	High						89.02	87.79	86.51	85.22	84.04	82.82	0.92	0.89	0.86	0.85	0.85

The qualitative uncertainty score is shown in **Results-GHG** row 69.

Total other benefits resulting from primary rebound effects (£) (row 72:88)

The discounted cost of GHG emissions is fed from **Calculations-GHG (central, low and high)** rows 619:644 for each year of the assessment.

Discounted monetised value of rebound effects

(minus indicates benefits)

Units: £k (2014 prices)		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	Central						-15.37	-15.10	-14.83	-14.55	-14.28	-14.01	0.00	0.00	0.00	0.00	0.00
	Low						-14.75	-14.34	-13.93	-13.52	-13.13	-12.75	0.00	0.00	0.00	0.00	0.00
	High						-17.73	-17.43	-17.12	-16.80	-16.50	-16.20	0.00	0.00	0.00	0.00	0.00
Total	Central						-15.37	-15.10	-14.83	-14.55	-14.28	-14.01	0.00	0.00	0.00	0.00	0.00
	Low						-14.75	-14.34	-13.93	-13.52	-13.13	-12.75	0.00	0.00	0.00	0.00	0.00
	High						-17.73	-17.43	-17.12	-16.80	-16.50	-16.20	0.00	0.00	0.00	0.00	0.00

The qualitative uncertainty score is shown in **Results-GHG** row 88.

Discount cost over appraisal period and quantified net present value (£) (rows 91:110)

This table sums the calculated discounted costs/savings (in the three previous tables above) on the projected monetised value of carbon, energy change and benefits resulting from primary rebound effect.

Total monetised impact

(minus indicates benefits)

Units: £k (2014 prices)		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Traded	Central						0.85	0.88	0.88	0.90	0.91	0.93	0.92	0.89	0.86	0.85	0.82
	Low						0.76	0.78	0.78	0.79	0.81	0.82	0.83	0.80	0.78	0.77	0.74
	High						1.09	1.11	1.08	1.07	1.07	1.05	1.04	1.00	0.96	0.95	0.94
Non-traded	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	Central						70.31	69.26	68.27	67.26	66.24	65.26	0.00	0.00	0.00	0.00	0.00
	Low						54.03	51.89	49.85	47.84	45.95	44.14	0.00	0.00	0.00	0.00	0.00
	High						102.20	100.70	99.19	97.68	96.24	94.79	0.00	0.00	0.00	0.00	0.00
Non-fuel emissions	Central						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Low						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CO2e	Central						71.17	70.15	69.15	68.16	67.15	66.18	0.92	0.89	0.86	0.85	0.82
	Low						54.79	52.67	50.63	48.63	46.76	44.97	0.83	0.80	0.78	0.77	0.74
	High						103.29	101.81	100.28	98.75	97.31	95.84	1.04	1.00	0.96	0.95	0.94

The qualitative uncertainty score is shown in **Results-GHG** row 110.

Results-Summary sheet

Data is imported from **Results-GHG** sheet, table 1 Net carbon emissions in ktonnes CO_2e to the **Results-Summary** rows 70:75 where the appraisal years are summed and presented as emission change in CO_2e and the total net present value in £thousand in the table. The figure below shows an example of the final summary results.

Box 47 Results- GHG and Results-Summary

GHG

npv 2014 prices	Change in emissions Thousand tonnes CO2e			Total monetised impact NPV £k (2014 prices)			Comments
	Central	Low	High	Central	Low	High	
Total impact	2.30	2.30	2.30	416	302	602	

7.5 Limitations

- The modelling process is based on a number of assumptions and simplifications, meaning the outputs contain some level of uncertainty. In part this is due to the uncertainties associated with the inputs, including:
  - Carbon and fuel price estimates.
  - Estimated changes in net energy use.
  - Quantification of GHG emissions resulting from non-fuel changes.
  - Estimation of rebound effects.
- The method is restricted to identify changes in energy consumption as a result of a policy, and how this is reflected in changed GHG emissions. Changes related to non-fuel GHG emissions (e.g. formation of CO_2 through use of limestone in wet scrubbing) are not captured in the methodology. The change in the level of non-fuel GHG emissions will be variable depending on the technology or measure used and the sector to which it applies (i.e. how this leads to changes in process emissions). A bespoke quantification on the basis of specific evidence would therefore be more suitable than the use of a generic model results of which would involve high levels of uncertainty. If data on net changes in non-fuel GHG emissions are available, the user of the model will be able to input them so that they are valued alongside energy related GHG emissions.
- The model is not designed to calculate the embedded carbon associated with policies (unless the net energy change accounts for this) due to the high levels of uncertainty associated in such assessments and low availability of data on materials used.

8. Method to assess impacts on affordability for businesses

8.1 Overview

The primary method for estimating the impacts on business affordability of the potential future policy interventions is based on the relationship between additional costs to businesses and their capacity to cope with these costs. Particular challenges may concern small and medium enterprises (SMEs) and/or business with limited or no ability to pass on additional costs to downstream users or consumers.

The approach used in this model for both the "affordability" and "distributional" impact is based on cost ratios (in line with EU Commission Impact Assessment guidelines). In this context we define "affordability" as the ability of a business to meet the costs resulting from a given policy without incurring in financial difficulties. This is assessed by comparing the policy cost against an indicator of the level of financial resources available to the business.

The chosen indicator is the Gross Operating Surplus (GOS). GOS is the capital available to incorporated companies which allows them to repay their creditors, to pay taxes and eventually to finance all or part of their investment[18]. Considering that GOS can be used for financing investment, it is therefore a relevant indicator as to how much money a business has available to face an increase in costs before capital charges. Following other precedents[19], we therefore use it as the default metric for assessing the economic impacts of a proposed measure on businesses. While it is not a perfect proxy for company's robustness to costs of new policies, it provides a reasonable, available and consistent statistic to help judge the resources likely to be available to very diverse business base. Differences in sectors structure will need to be considered.

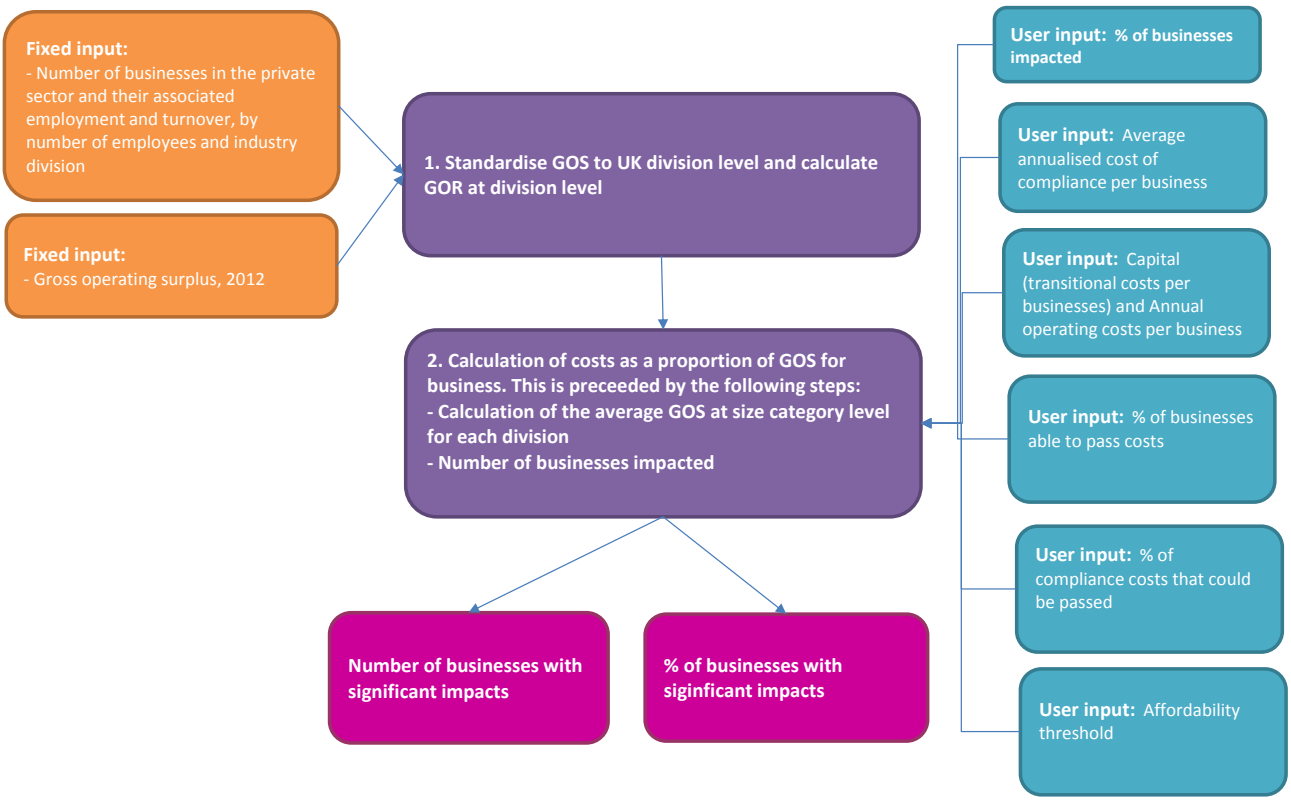
Data has been extracted from two official sources at UK level. These are the Department for Business Innovation and Skills (for business numbers and turnover), and the Office of National Statistics for the GOS.

Although some adjustments had to be done to the input tables in order to feed the model, these were built in the model without altering the original input format. This was done to facilitate future updates. However, any small change in the format of future updates will require the inputs to be revised and ensure they are feeding correctly into the calculations step.

[18] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Gross_operating_surplus_(GOS)_-_NA

[19] See section 7 of the Impact Assessment of the Transposition of Articles 14(5)-(8) of the Energy Efficiency Directive (2012/27/EU) undertaken for DEFRA: http://www.doeni.gov.uk/defra_uk_wide_regulatory_impact_assessment_on_the_energy_efficiency_directive.pdf

Figure 8.1 Overview of the methodology to assess impacts on business affordability



8.2 Inputs

Inputs used to calculate the impacts on business affordability are summarised in Table 8.1 below.

Table 8.1 Summary of inputs – Affordability for businesses

Input	Units	Comment	Mandatory/ Optional	Source
User Inputs:				
Percentage of businesses impacted	%	For every industry division and business size that are expected to be affected by the policy, the user has to provide which percentage of these business will be impacted.	Mandatory (either at division or size category level)	Assessment of the measure
Average annualised cost of compliance per business	£thousand per year	The user can provide the average annualised cost per business for any division/size affected. This is figure must take into account all the costs incurred by the businesses.	Optional – User can input this or capital and operating cost.	Assessment of the measure
Capital (transitional costs per businesses)	£thousand	Alternatively to the average annualised total cost, the user can provide a one-off capital (transitional) cost.	Optional – User can input this together with operating cost or average annualised cost.	Assessment of the measure

Input	Units	Comment	Mandatory/ Optional	Source
Annual operating costs per business	£thousand per year	Together with capital costs, the user can provide an estimate of the average annual operational cost per business as a result of the policy.	Optional – User can input this together with capital cost or average annualised cost.	Assessment of the measure
Percentage of businesses able to pass costs	%	For a given combination of industry division and business size, the proportion of businesses will be able to pass costs downstream.	Mandatory (either at division or size category level)	Assessment of the measure
Percentage of compliance cost that could be passed	%	For those businesses able to pass costs downstream, the average proportion of additional costs that would be passed.	Mandatory (either at division or size category level)	Assessment of the measure
Number of years for annualisation of capital cost	Years	This is used to annualise capital costs. If left blank the number of years between the start and the end of the assessment is used as a default value.	Optional – Only necessary if user is entering capital (transitional) costs. Default values apply if left blank.	Assessment of the measure
Affordability thresholds	%	The ratio (policy costs compared to business GOS) above which the measure could be considered difficult to afford (or unaffordable) for the businesses in that division/size. Four different thresholds allowed.	Optional – These inputs are necessary but default values of 10%, 20%, 50%, and 75% can be used.	Assessment of the measure
Fixed Input:				
Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division	Various	Only number of businesses and turnover is further used in the calculations.		BIS Statistics, Business population estimates.
Gross operating surplus, 2012	£million	Provided by the source in a non-consistent aggregation level.		Office of National statistics, Input-Output Supply and Use Tables - 1997-2012

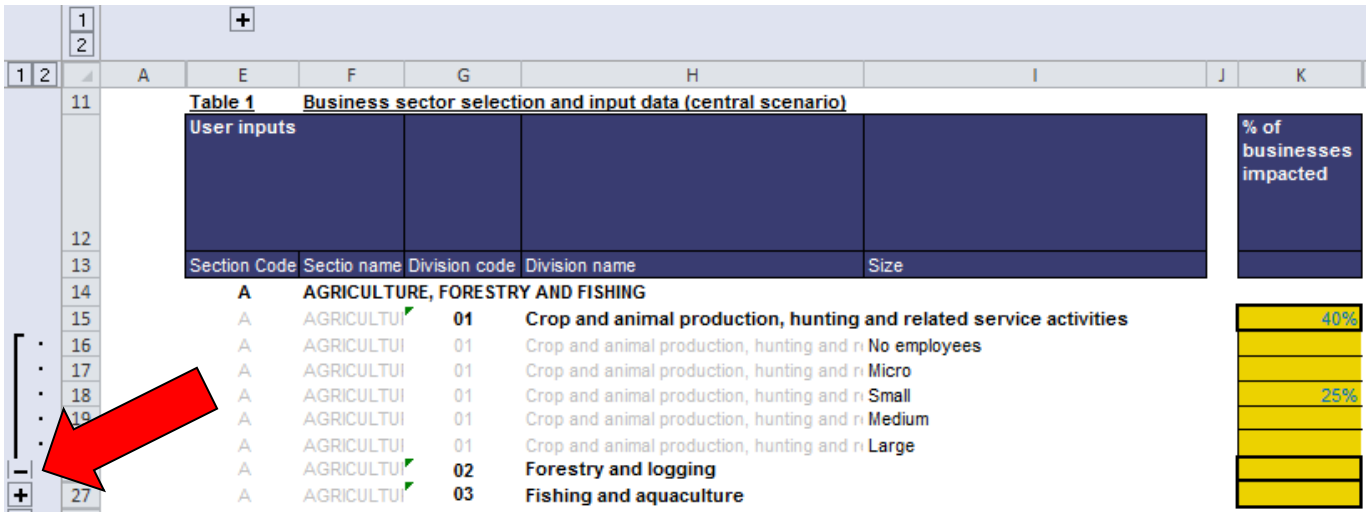
User inputs

User inputs are entered in the sheet **Control-BusinessAfford**. In order to account for uncertainty in a quantitative manner, the analysis is divided in three scenarios: Central, Low and High. The structure and format of the inputs are identical for the three scenarios, being the input tables for the three scenarios located in the same sheet. Table 1 hosts inputs for central scenario, Table 2 for low and Table 3 for high.

There are three levels of disaggregation in the analysis of businesses. They are business section (characterised by a letter following the NACE codes – E.g. A: Agriculture, Forestry and Fishing), business division (characterised by a 2-digit code – E.g. 02: Forestry and logging) and business size (e.g. micro, small, etc.).

The user can operate either at division or size level. If the user has data at division level, this has to be input in the cells with a thick black border (e.g. Rows 15, 21, 27, etc.). If data is available at business size level, this can be added by expanding the grouped rows. An example is provided in Figure 8.2 (central scenario). Inputs at business size level have priority over division level. This means that in the example below, the division level value of 40% will be applied to all sizes excepting for small businesses, which have their own input value.

Figure 8.2 Entering inputs at industry division and business size level

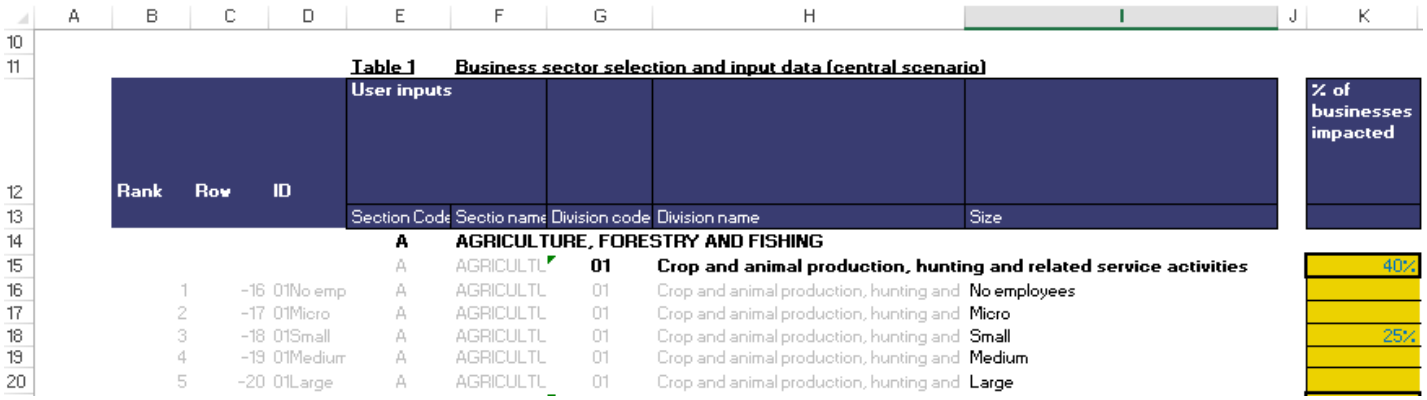


11	Table 1	Business sector selection and input data (central scenario)					
12	User inputs						% of businesses impacted
13	Section Code	Sectio name	Division code	Division name	Size		
14	A	AGRICULTURE, FORESTRY AND FISHING					
15	A	AGRICULTUI	01	Crop and animal production, hunting and related service activities			40%
16	A	AGRICULTUI	01	Crop and animal production, hunting and r	No employees		
17	A	AGRICULTUI	01	Crop and animal production, hunting and r	Micro		
18	A	AGRICULTUI	01	Crop and animal production, hunting and r	Small		25%
19	A	AGRICULTUI	01	Crop and animal production, hunting and r	Medium		
20	A	AGRICULTUI	01	Crop and animal production, hunting and r	Large		
27	A	AGRICULTUI	02	Forestry and logging			
	A	AGRICULTUI	03	Fishing and aquaculture			

Given the large number of combinations of divisions and size categories, only those divisions/size categories that have inputs are carried through the calculations. The model operates following a system of unique row IDs created by the combination of division and business size. The rows are selected by adding a numerical value in the first user input (Column K). Figure 8.2 shows an example of the collapsed Columns B:D which act as selectors. Whenever the user adds an input at division level, the model creates unique IDs in Column D for each business size within that division. This unique IDs are based on the division code and business size. Columns B and C rank the rows so they appear in the same order in the calculations and results. More specifically, Column C shows the row number for each row containing input data and Column B ranks it in ascending order. If inputs are added for one specific business size, but not at division level, only the selected business size will be considered in the calculations.

The tool is originally designed to compare the same business divisions and size categories between the three scenarios (central, low and high). However, if the user wants to compare different divisions/sizes between scenarios, please add a zero in column K for those divisions/ sizes that do not take part in one of the scenario analysis instead of leaving it blank. This way, unique IDs will still be created and rows will be carried forward.

Figure 8.3 Detail on the selecting method for unique rows



11				Table 1	Business sector selection and input data (central scenario)				
12	Rank	Row	ID	User inputs					% of businesses impacted
13				Section Code	Sectio name	Division code	Division name	Size	
14				A	AGRICULTURE, FORESTRY AND FISHING				
15				A	AGRICULTL	01	Crop and animal production, hunting and related service activities		40%
16	1	-16	01No emp	A	AGRICULTL	01	Crop and animal production, hunting and	No employees	
17	2	-17	01Micro	A	AGRICULTL	01	Crop and animal production, hunting and	Micro	
18	3	-18	01Small	A	AGRICULTL	01	Crop and animal production, hunting and	Small	25%
19	4	-19	01Mediur	A	AGRICULTL	01	Crop and animal production, hunting and	Medium	
20	5	-20	01Large	A	AGRICULTL	01	Crop and animal production, hunting and	Large	

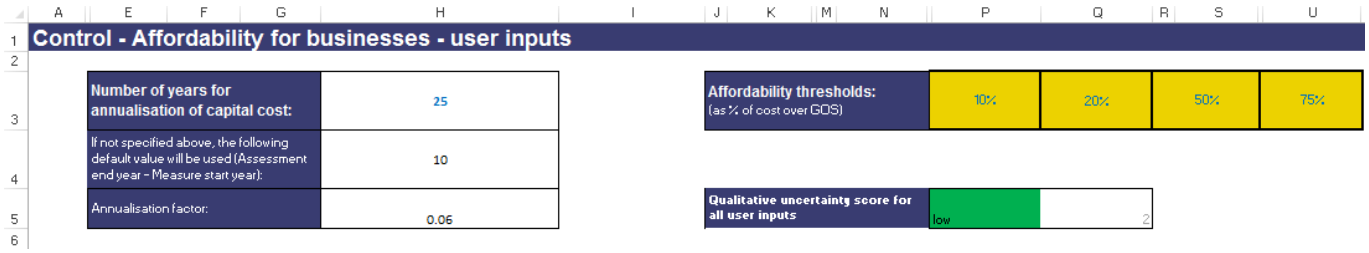
The **user inputs** required to calculate the impact which is divided in four main blocks: *Annualisation timescale and user qualitative uncertainty*, *Percentage of businesses impacted*, *Cost per business* and *Capacity of passing costs.*

Annualisation timescale, affordability thresholds and user qualitative uncertainty

These three inputs are common to all scenarios and only need to be entered once:

- **Control-BusinessAfford** "*Number of years for annualisation of capital cost*" (E3:H5): If using capital (transitional) costs for businesses as an input, enter the number of years to be used in the annualisation of the capital costs in Cell H3. If this cell is left blank the model will use the appraisal period displayed in Cell H4 as the default annualisation period. The appraisal period is calculated as *Assessment end year* minus *Measure start year*. Cell H5 displays the annualisation factor. This is calculated with the Excel function PMT and uses number of years and the discount rate specified in the Control tab as the main variables.
- **Control-BusinessAfford** "*Affordability thresholds*" (J3:U3): Enter the ratio (policy costs compared to business GOS) above which the measure could be considered difficult to afford (or unaffordable) for the businesses in that division/size. The tool allows for four different thresholds to be applied. By default, 10%, 20%, 50% and 75% are applied but these can be changed by the user. Calculated costs will be compared to these thresholds to show the number (and proportion) of business affected under each of them.
- **Control-BusinessAfford** "Qualitative *uncertainty score for all user inputs*" (J5:Q5): If a numerical data range for uncertainty is not available, an estimate of the level of uncertainty associated with the central values should be selected in Cell P3. The resulting uncertainty score will be displayed in Cell Q3. If a quantitative uncertainty range is available (and data is filled in for the low and high scenarios as well as central scenarios), the user should select "not used" in this cell.

Figure 8.4 Selecting the annualisation period and qualitative uncertainty



Percentage of businesses impacted

- **Average annualised cost of compliance per business:** The user needs to make an estimate of the number of businesses within that division and business size (e.g. proportion of small businesses within the forestry and logging sector that will be impacted by the policy). As explained above, data can be added at division level (e.g. proportion of total businesses within the forestry and logging sector that will be impacted). As illustrated in Figure 8.4 above, % of businesses impacted has to be entered in **Control-BusinessAfford** (Column K).

Cost per business

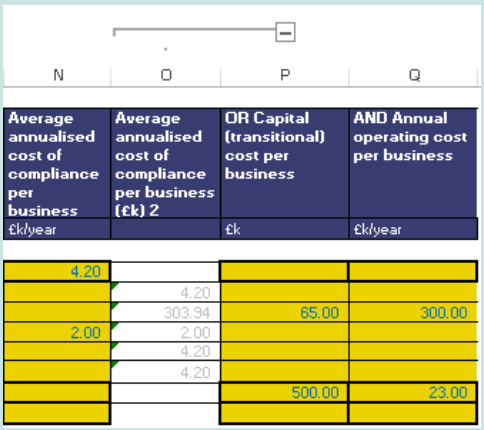
The assessment method has been designed only to assess the impact of costs of compliance on business affordability (i.e. the negative values corresponding to benefits to business should not be entered in the worksheet **Control-BusinessAfford**).

- **Average annualised cost of compliance per business**: If the user does not have detailed data on transitional and annual costs, but has a figure on total annualised cost per business (in £k per year), s/he can enter it in **Control-BusinessAfford** (Column N). Alternatively, the user can enter cost data using the next two columns explained below.

- **Capital (transitional) cost per business**: If detailed data is available the user must enter one-off capital (transitional) costs per business in thousand pounds here (Column P).
- **Annual operating cost per business:** If detailed data is available the user must enter annual operational costs per business in thousand pounds here (Column Q).

Box 48 Cost per business

Cost per business must be added following one of this two options: entering total annualised cost or entering capital and operational costs. These can be done at division and size level. The methods are exclusive at row level but not within a division. This means that the user can provide a total annualised cost per business at division level and detailed capital and operational costs for some specific business sizes. Preference is given to detailed cost inputs so, in case of input conflict the prioritisation will be solved as follow: Size level detailed costs > division detailed costs > size level total annualised cost > division level total annualised costs.



N	O	P	Q
Average annualised cost of compliance per business	Average annualised cost of compliance per business (£k) 2	OR Capital (transitional) cost per business	AND Annual operating cost per business
£k/year		£k	£k/year
4.20			
	4.20		
	303.94	65.00	300.00
2.00	2.00		
	4.20		
	4.20		
		500.00	23.00

The right cost value is selected and calculated in the collapsed Column O. This column has been grouped and hidden to avoid confusing the user and prevent manual alteration. These data are carried forward into **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (K7:K100).

Capacity of passing costs

- **% of businesses able to pass costs**: The user must enter the percentage of businesses within that division/size that would be able to pass through a portion (or all) of the additional costs to the next stage in the supply chain and/or to the final consumer (Column S).
- **% of compliance cost that could be passed:** For those businesses able to pass costs downstream, the user must enter the average proportion of additional costs that would be passed. If no businesses within that division/size is able to pass costs (i.e. Column S = zero) the field must be set to zero (Column U).

Box 49 Capacity of passing costs

Control-BusinessAfford (Columns S to V) provide the necessary information to estimate the capacity of businesses to pass costs further down in the supply chain and/or to final customers. Like in the other inputs for this impact, the user can enter data at division level and/or business size level. In the example below, if we compare columns S and T, we can see a value of 40% (0.40) is applied to all business sizes excepting those that have a specified input (25% or 30%).

S	T	U	V
% of businesses able to pass costs	% of businesses able to absorb costs 2	% of compliance cost that could be passed	% of compliance cost that could be passed 2
%		%	
40%		30%	
	0.40		0.30
25%	0.25	15%	0.15
25%	0.25	15%	0.15
	0.40		0.30
	0.40		0.30
30%	0.30	20%	0.20

The right values are selected in the collapsed Columns O, V and X. These columns will not be manipulated by the user. They have been grouped and hidden in the model to avoid confusing the user and prevent manual alteration. These data are carried forward into **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (M7:O100).

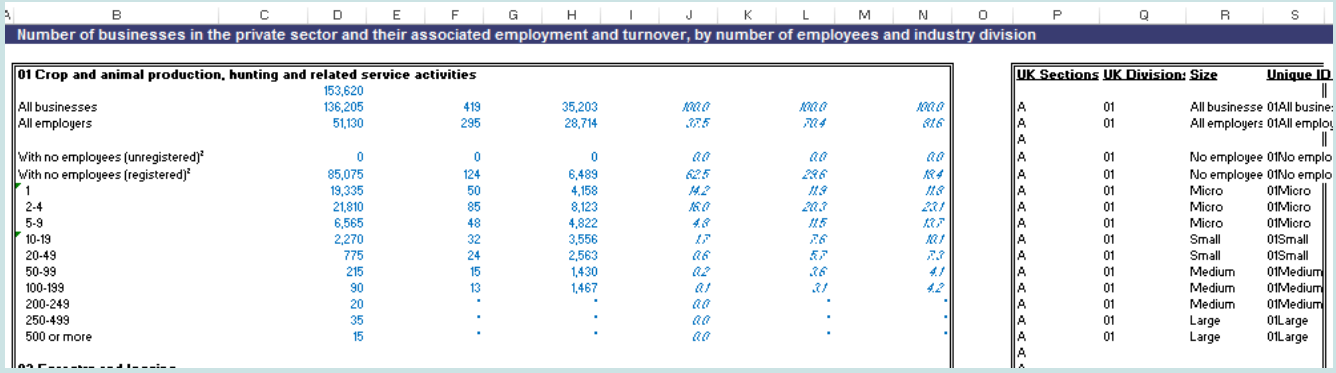
Fixed inputs

The **fixed inputs** required to calculate the impact are:

- Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division: This provides data on the number of businesses for each industry division and business size, as well as turnover (in £million). The source for these data is Department for Business Innovation and Skills, October 2013, Business Population Estimates for the UK and Regions, Table 6 - UK Divisions. Employment is not used in the calculation of this impact.

Box 50 Number of businesses and their associated turnover by number of employees and industry division

Number of businesses and their turnover are presented in **Inputs-BusinessAfford** (rows 6:1548). This data is provided only for the moment of publication (start of 2013). The categories and format of Columns B: N is consistent with BIS Business Population Estimates, Table 6. However, some data aggregation has been carried out to feed into the calculations. While the original data is provided in a series of size ranges according to number of employees, the tool considers 5 business size categories: No employees, micro, small, medium and large. In Columns P:S, the modellers have added an aggregation system following this rules: No employees = No employees, 1-9 employees = micro, 10-49 employees = small, 50-249 employees = medium, 250 or more = Large.



Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division

01 Crop and animal production, hunting and related service activities						
	153,620					
All businesses	136,205	419	35,203	100.0	100.0	100.0
All employers	51,130	295	28,714	37.5	70.4	81.6
With no employees (unregistered)[2]	0	0	0	0.0	0.0	0.0
With no employees (registered)[2]	85,075	124	6,489	62.5	29.6	18.4
1	19,335	50	4,158	14.2	11.9	11.8
2-4	21,810	85	8,123	16.0	20.3	23.1
5-9	6,565	48	4,822	4.8	11.5	13.7
10-19	2,270	32	3,556	1.7	7.6	10.1
20-49	775	24	2,563	0.6	5.7	7.3
50-99	215	15	1,430	0.2	3.6	4.1
100-199	90	13	1,467	0.1	3.1	4.2
200-249	20	.	.	0.0	.	.
250-499	35	.	.	0.0	.	.
500 or more	15	.	.	0.0	.	.

UK Sections	UK Division	Size	Unique ID
A	01	All businesse	01All busine
A	01	All employers	01All employ
A			
A	01	No employee	01No emplo
A	01	No employee	01No emplo
A	01	Micro	01Micro
A	01	Micro	01Micro
A	01	Micro	01Micro
A	01	Small	01Small
A	01	Small	01Small
A	01	Medium	01Medium
A	01	Medium	01Medium
A	01	Medium	01Medium
A	01	Large	01Large
A	01	Large	01Large
A			

Columns S creates a group ID using division code and size to aggregate the groups and match fixed inputs from that group with user inputs. The aggregated data is carried forward into **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (J107:K200).

- **Gross Operating Surplus (GOS)**: This presents the GOS by industry divisions (or group of industry divisions). The GOS is the capital available to incorporated companies which allows them to repay their creditors, to pay taxes and eventually to finance all or part of their investment. It is used as a relevant indicator as to how much money a business has available to face an increase in costs before capital charges.

Box 51 Gross Operating Surplus

GOS is presented in **Inputs-BusinessAfford** (rows 1559:1667). This data is provided for 2012. The categories and format are consistent with ONS, Input-Output Supply and Use Tables - 1997-2012, Table 2. However, in several cases the aggregation does not correspond exactly to division level. In the example below, Row 1567 provides the GOS for divisions 06 and 07 together. On the contrary, in row 1571 it provides the GOS for two sub-divisions (10.2 and 10.3).

Gross operating surplus

UK Division Code	UK Division	GOS (£m
01	Crop And	7 076
02	Forestry And	81
03	Fishing And	323
05	Mining Of Coal	- 127
06 & 07	Extraction Of	18 755
08	Other Mining	1 497
09	Mining	2 876
10.1	Processing	404
10.2-3	Processing	437

These inputs are carried forward in their original format and disaggregation level into **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (C220:F325).

8.3 Calculations

Calculations are undertaken in the following worksheets: **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high)** separately for each uncertainty scenario**.** The assessment method is comprised of the following steps:

- **Step 1: Standardise GOS to UK division level and calculate GOR at division level**

For some industry divisions, the original GOS data is provided in a different aggregation level (i.e. provided in a more detailed level or aggregated with other divisions). For those divisions that require it, this step derives the GOS. Gross Operating Rate (GOR) is calculated as a proportion of total GOS to turnover at division level.

Box 52 Standardise GOS to UK division level and calculate GOR at division level

For those divisions which GOS is not directly available, the GOS is derived by aggregating or disaggregating the values from the original sources. Original values are imported from **Inputs-BusinessAfford** (rows 1559:1667) to **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (C220:F325). In Column J the derived GOS is calculated. This is done for each division individually applying different formulas. If the original GOS is disaggregated in sub-divisions, the derived GOS will be the sum of them. If the original GOS is aggregated with several divisions, the derived GOS is weighted by turnover at division level (Column M).

Column N calculates the Gross Operating Rate (GOR). This is a ratio of GOS per unit of turnover (Column J divided by Column N) expressed in per cent. If not turnover is available in the sources for any specific division, the cell will read "*No turnover data*".

H	I	J	K	L	M	N
UK Division Code		Derived GOS (£million)			Turnover at division level	GOR at division level
01		7 076			35 203	20%
02		81			1 233	7%
03		323			1 693	19%
05		- 127			*	No turnover da
06		18 755			77 486	24%
07		*			*	No turnover da
08		1 497			2 511	60%
09		2 876			6 679	43%
10		2 807			76 319	4%
11		2 194			17 669	12%

The GOR is carried forward to **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (N352:N445).

- **Step 2: Calculation of cost as a proportion of GOS for businesses**

This step calculates the ratio costs/GOS for businesses able to pass costs and unable to do so. This is done in three sub-steps by using inputs from the summary input and *Step 1*. These steps involve the calculation of the average GOS at size category level for each division, the annualised cost per business at size category and the cost as proportion of GOS for businesses that are able and unable to pass costs downstream. The second step is calculated in **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (Rows 350:445).

Box 53 Calculation of cost as a proportion of GOS for businesses

Average GOS at size category level for each division

This sub-step is calculated in columns **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (M352:O445). First, in column M it calculates the average turnover per business for each row by dividing total turnover by number of businesses at size category level (Column K / Column J).

Column N imports the relevant GOR from *Step 1* (**Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (N220:F325).

Column O calculates the average GOS at size category level by multiplying the average turnover per business by the GOR (Column O * Column N).

Number of businesses impacted

This sub-step is calculated in columns **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (Q352:R445). This is done in column R by multiplying the percentage of businesses impacted (Column Q) by the total number of businesses (Column J). The percentage of businesses impacted (Column Q), is imported from the inputs in **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (J7:J100)

M	N	O	P	Q	R
Calculates average GOS at size category level for each division				Calculates number of businesses impacted	
Average turnover per business per size	**GOR at division level**	**Average GOS at size category level**		**% of businesses impacted**	**Number of businesses impacted**
£k	%	£k			
76	20%	15.3		40%	34,030
358	20%	72.1		40%	19,084
2,010	20%	403.9		25%	761
8,914	20%	1,791.7		40%	130
Insufficient dat	20%	Insufficient data		40%	20

Calculates cost as a proportion of GOS

This sub-step is calculated in two different phases. First, it is calculated for businesses unable to pass costs. This is done in columns **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (T352:U445). The function in column U divides the annualised cost per business (Column T) by the average GOS at size category level (Column O). The annualised cost per business (Column T), is imported from the inputs in **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (K7:K100).

The second part calculates the cost as a proportion of GOS for businesses able to pass costs. This is done in columns **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (W352:AD445). Column X calculates the number of businesses able to pass costs by multiplying the number of businesses impacted (Column R) by the proportion of businesses able to pass costs (Column W). The % of businesses able to pass costs (Column W) is imported from the inputs **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low)** and **Calcs-BusinessAfford (high),** (M7:M100).

Number of businesses unable to pass costs (Column Y) is calculated by subtracting the number of business able to pass cost (Column X) from the number of impacted businesses (Column R).

Annualised cost passed per able business (Column AB) is calculated by multiplying the Annualised cost per business (Column T) by % of compliance cost that could be passed (Column AA). Annualised cost absorbed per able-to-pass business equals total annualised cost per business (Column T) minus Annualised cost passed per able business (Column AB).

The final output Cost as % of GOS for businesses able to pass costs is calculated by dividing the Annualised cost absorbed per able-to-pass business (Column AC) by Average GOS at size category level (Column O).

Box 53 Calculation of cost as a proportion of GOS for businesses

T	U	V	W	X	Y	Z	AA	AB	AC	AD
Calculate cost as proportion of GOS			Accounts for the fact that some business will be able to pass some or all costs further downstream							
Annualised cost per business	Cost as % of GOS for businesses unable to pass costs		% of businesses able to pass costs	Number of businesses able to pass costs	Number of businesses unable to pass costs		% of compliance cost that could be passed	Annualised cost passed per able business	Annualised cost absorbed per able-to-pass	Cost as % of GOS for businesses able to pass costs
£k	%							£k	£k	%
4.20	27%		40%	13,612	20,418		30%	1.26	2.94	19%
103.94	144%		25%	4,771	14,313		15%	15.59	88.35	123%
2.00	0%		25%	190	571		15%	0.30	1.70	0%
4.20	0%		40%	52	78		30%	1.26	2.94	0%
4.20	Insufficient data		40%	8	12		30%	1.26	2.94	Insufficient data

Qualitative uncertainty score for every sub-step is displayed in row 447 under each column.

8.4 Results-affordability for business and results-summary

The calculation assessment above (section 8.3) provides the outputs of the total number of businesses affected and the expected costs they will face in relation to their GOS. The information is fed directly into the **Results-BusinessAffordability** sheet (Rows 1:108).

Results-BusinessAffordability (Columns I:U): Provide an extract of the intermediate outputs from the calculation sheets for the three scenarios. These are compared to each of the specified thresholds to obtain the final results:

- Number of businesses with significant impact

Box 54 Number of businesses with significant impact

This final output is presented in **Results-BusinessAffordability** (Columns W:Z) for the central scenario, (Columns AF:AI) for the low scenario and (Columns AO:AR) for the high scenario. Each column presents the results under a specific threshold. This output presents the number of businesses that will be affected by each division/size combination. It is calculated by comparing the cost as percentage of GOS for businesses with the user define thresholds (Cells K9:N9). This is done for business unable to pass costs (Columns I:K) and able to pass costs (Columns L:N). If the ratio Additional Cost/GOS is higher than the threshold, the number of businesses (Columns P to U) will be flagged as impacted. This is done separately for businesses able and unable to pass costs and summed up to show a final number of impacted businesses. Note thresholds are common for the three scenarios (central, low, high).

The figure below shows the intermediate outputs that feed into the final results. Final results are illustrated in Box 55.

	I	J	K	L	M	N	O	P	Q	R	S	T	U
7													
8	Cost as % of GOS for businesses unable to pass costs			Cost as % of GOS for businesses able to pass costs				Number of businesses unable to pass costs			Number of businesses able to pass costs		
9	Central	Low	High	Central	Low	High		Central	Low	High	Central	Low	High
10	%	%	%	%	%	%							
11	27%	27%	65%	8%	8%	10%		20,418	13,612	34,030	13,612	20,418	8,508
12	422%	422%	422%	63%	127%	63%		14,313	9,542	19,084	4,771	9,542	4,771
13	0%	0%	0%	0%	0%	0%		571	381	571	190	381	190
14	0%	0%	1%	0%	0%	0%		78	52	130	52	78	33
15	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data		12	8	20	8	12	5
16	2267%	2267%	16%	453%	499%	8%		844	603	-	362	603	275
17	286%	286%	4%	143%	143%	0%		-	-	18	275	275	-
18	44%	44%	Insufficient data	0%	0%	Insufficient data		18	18	Insufficient	-	-	Insufficient

- **Percentage of businesses with significant impact**

This additional output presents the proportion of businesses affected by the policy from the total number of businesses per division and size category. This is done for low, high and central uncertainty scenario.

Box 55 Percentage of businesses with significant impact

This output is calculated dividing the Number of businesses affected under each of the specified thresholds by the total number of businesses per division/size category. (**Results-BusinessAffordability** (Columns W:Z) for the central scenario, (Columns AF:AI) for the low scenario, (Columns AO:AR) for the high scenario/ **Calcs-BusinessAfford (central), Calcs-BusinessAfford (low), Calcs-BusinessAfford (high)** (J352:J445).

The figure below shows an example of the two final outputs for the central scenario under different thresholds.

Central scenario							
Number of businesses with significant impact				% of businesses with significant impact			
Threshold 0.1	Threshold 0.2	Threshold 0.5	Threshold 0.75	Threshold 0.1	Threshold 0.2	Threshold 0.5	Threshold 0.75
				%	%	%	%
42,538	42,538	29,776	-	50%	50%	35%	0%
14,313	-	-	-	30%	0%	0%	0%
-	-	-	-	0%	0%	0%	0%
-	-	-	-	0%	0%	0%	0%
Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
4,824	4,824	4,824	4,824	40%	40%	40%	40%
550	385	-	-	40%	28%	0%	0%
-	-	-	-	0%	0%	0%	0%
Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data

The percentage of businesses with a significant impact are shown in **Results-BusinessAffordability** (Columns AA:AD) for the central scenario, (Columns AJ:AM) for the low scenario and (Columns AS:AV) for the high scenario. The qualitative uncertainty category associated with the final result can be found in row 110.

The summary of the results for the assessment of affordability for business is presented in **Results-Summary.**

Box 56 Results-Summary Affordability for employment

Summary of the results for the impact is presented in **Results-Summary** rows 78:88. The figure below shows an example of the final summary results. Results offer total number of impacted businesses across sectors under each threshold and scenario. It also show the proportion of impacted businesses against total number of businesses within affected division/size categories.

Business affordability

		Central							
Size	Number of businesses in affected sectors	Number of businesses with significant impact (by threshold)				% of businesses in affected sectors with significant impact (by threshold)			
		10%	20%	50%	75%	10%	20%	50%	75%
No employees	97,135	47,362	47,362	34,600	4,824	49%	49%	36%	5%
Micro	49,085	14,863	385	0	0	30%	1%	0%	0%
Small	3,165	0	0	0	0	0%	0%	0%	0%
Medium	330	0	0	0	0	0%	0%	0%	0%
Large	50	0	0	0	0	0%	0%	0%	0%
Total	149,765	62,225	47,747	34,600	4,824	42%	32%	23%	3%

8.5 Limitations

- For this impact the model can handle a maximum of 94 rows, that is, unique combinations of industry division and sizes.

- The default thresholds in the model have been used to provide the user with a range of possible impacts. These thresholds are assumptions which have not been validated by evidence in the literature, having not been contained in the literature identified, or through direct liaison with businesses, due to the resource constraints of this project. Determination of what is considered "affordable" for a business is dependent on the economic activity of the business and its size. It is advisable that in order to obtain results specific for a given sector affected by the policy, the affordability thresholds are determined by the user through industry surveys or defined on the basis of previous studies.
- The model can provide the number of businesses that would be impacted and an estimate of the degree of this impact at division and business size level. However, in reality different businesses within the same division and size will be impacted to a different degree. This level of detail cannot be captured by the generic modelling undertaken in the wider impacts model.
- Official government guidelines lack clear recommendations on the type of the indicator to use for the assessment of business affordability. In the absence of clear guidelines, GOS was selected as a measure of the resources available to businesses for making investments. Use of GOS is not unpinned by specific economic theory, however in the absence of readily available data on companies' profits, GOS was considered the best available indicator. GOS information was only available at a UK division level, and not per business size category.
- For some business sectors, publicly available data from the fixed inputs (employment figures, turnover, GOS) is limited, being sometimes not disclosed and marked as confidential. This is particularly relevant for data on large businesses in sectors where only a few large companies operate.

9. Method to assess impacts on employment

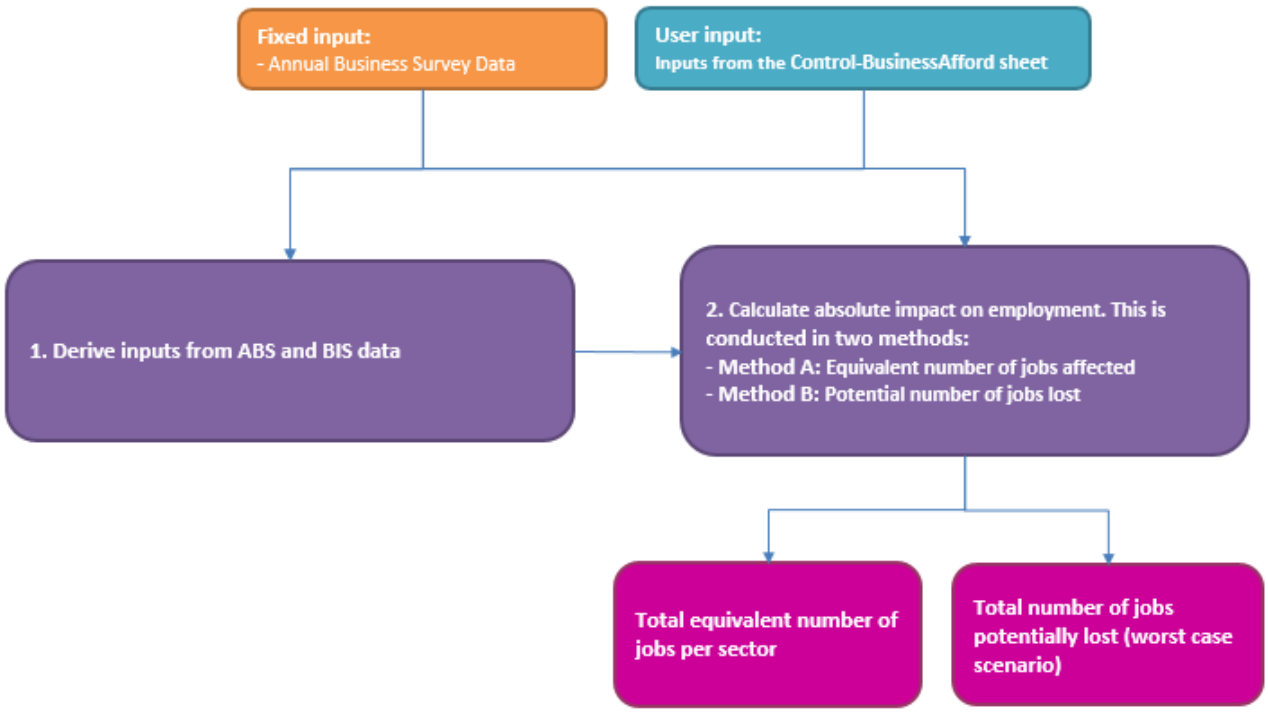
9.1 Overview

Employment is one of the key measures of the economic impact of an intervention. According to the HM Treasury Green Book, assessment of employment impacts is required when a policy considered is likely to have an impact on the supply-side. Assessment of net employment impacts in quantitative terms, spatially and sectorally, requires the use of macro-economic models. These models are capable of addressing legislative proposals and assessing impacts at regional and national scale. Simpler approaches are used to assess impacts of projects on employment, for example as part of the socio-economic impact assessments for new construction projects (in the context of air quality these could be for example new wind farms). These often assess supply chain impacts using multiplier analysis and are preceded with detailed reviews of the labour market in the impacted areas.

Given the complexities of the methodologies to assess potential impacts of environmental regulation on employment, and lack of specific UK Government guidelines on the potential methods to be used, a simplified method was proposed for the inclusion in the Wider Impacts Model. The model is intended to serve as a tool for initial assessment of the scale of potential impacts, the assessment method was developed to provide the following information:

- "Labour cost as a share of total turnover (%)";
- "Equivalent number of jobs potentially affected", and
- "Number of jobs potentially lost".

Figure 9.1 Overview of the methodology to assess impacts on employment



9.2 Inputs

Inputs used to calculate the impacts on employment are summarised in Table 9.1 below.

Table 9.1 Summary of inputs – Employment

Input	Units	Comment	Source
User Inputs – (refer to section 8.2 and Inputs-BusinessAfford and Control-BusinessAfford sheets)			
Fixed Input:			
Annual business survey data	Various (£million and numbers)	Only number of businesses and turnover is further used in the calculations.	Office for National Statistics, 2013, Annual Business Survey (2013 Provisional Results)

User inputs

As employment impact is also calculated directly from the same information provided in the business affordability assessment. No data is required to be entered by the user for the employment. Instead, the user inputs which are entered for in the **Inputs-BusinessAfford**, and **Control-BusinessAfford- sheets** will feed into the **Calculations-Employment(central), Calculations- Employment (low)** and **Calculations- Employment (high)** sheets. In order to account for uncertainty in a quantitative manner, the analysis is divided in three scenarios: Central, Low and High. The structure and format of the inputs are identical for the three scenarios, as the input tables for the three scenarios located in the same sheet. The assessment method has been designed only to assess the impact of costs of compliance on employment (i.e. the negative values corresponding to benefits to business should not be entered in the worksheet Control-BusinessAfford).

Fixed inputs

The **fixed inputs** required to calculate the impact are:

- Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division: This provides data on the Number of businesses, their turnover (in £million), total employment and total costs (in £million). The source for these data is Office for National Statistics, 2013, Annual Business Survey (2013 Provisional Results)

Box 57 Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division

Number of businesses, their turnover, total employment and total costs are presented in **Inputs-Employment** (rows 7:495). The categories and format of Columns B:C is consistent with the Standard Industrial Classification (Revised in 2007). Data for the following parameters are taken from the Office for National Statistics, 2013, Annual Business Survey (2013 Provisional Results) to feed into subsequent calculations.

- Number of enterprises (number)
- Total turnover (£million)
- Approximate gross value added at basic prices (aGVA) (£million)
- Total purchase of goods, materials and services (£million)
- Total employment point in time (number)
- Total employment average during the year (number)
- Total employment costs (£million)
- Total net capital costs (£million)

Box 57 **Number of businesses in the private sector and their associated employment and turnover, by number of employees and industry division**

- Total net capital expenditure (£million)
- Total capital expenditure – acquisitions (£million)
- Total capital expenditure – disposals (£million)
- Total stocks and work in progress – value at end of year (£million)
- Total stocks and work in progress – value at beginning of year (£million)
- Total stocks and work in progress – increase during year (£million)

This data was copied into the fixed inputs sheet using the same format as the original source. This was done so the user can copy and paste updated data in the same input table in future updates. However, the user must ensure that the order of columns remains the same as currently. This is particularly important for columns B (division level code), D (year), E (number of enterprises), F (Total turnover), J (Total employment - average during the year) and K (Total employment costs).

Fixed inputs are currently provided for the years from 2008 to 2013. Only data for the most recent year is carried forward to the calculations. If future updates include more rows due to the addition of more years, the model will automatically use data for the most recent year as long as the same data is entered in each column and the year is specified in column D. Column A includes a function that specifies the division code for every individual row and should not be changed by the user. The model is able to accept inputs in the tab **Inputs-Employment** up to row 1000.

Annual business survey data

Standard Industrial Classification (Revised 2007) - Division level	Description	Year	Number of enterprises	Total turnover	Approximate gross value added at basic prices (aGVA)	Total purchases of goods, materials and services	Total employment - point in time [1]	Total employment - average during the year	Total employment costs	Total net capital expenditure	Total capital expenditure- acquisitions	Total capital expenditure - disposals	Total stocks and work in progress - value at end of year	Total stocks and work in progress - value at beginning of year	Total stocks and work in progress increase during year
			Number	£ million	£ million	£ million	Thousand	Thousand	£ million	£ million	£ million	£ million	£ million	£ million	£ million
01	Crop and animal production, hunting and related service activities	2008	6,239	2,626	766	1,887	27	25	253	136	168	32	132	118	13
		2009	3,456	2,203	696	1,501	22	22	272	73	124	51	130	138	-8
		2010	3,579	1,088	591	504	19	17	218	77	154	77	85	83	2
		2011	3,846	1,056	525	533	20	19	162	111	148	38	68	71	-3
		2012	4,020	1,117	554	592	21	21	220	83	125	42	120	109	11
		2013	4,488	1,443	807	649	18	18	246	150	222	72	92	87	5
02	Forestry and logging	2008	3,102	866	438	571	12	12	200	50	86	36	53	69	-16
		2009	3,072	805	382	562	14	14	220	93	137	44	42	46	-4
		2010	3,125	793	329	612	14	14	261	32	87	54	72	67	5
		2011	3,299	1,058	416	778	13	14	254	69	130	61	65	65	-
		2012	3,438	940	310	773	15	15	249	37	120	83	88	107	-19
		2013	3,669	1,254	422	946	13	14	260	48	98	50	226	235	-9
03	Fishing and aquaculture	2008	4,066	1,270	520	783	10	10	122	46	56	9	256	225	31
		2009	3,815	1,071	457	620	8	8	130	28	34	6	185	184	1
		2010	3,757	1,268	566	730	10	10	136	50	118	67	325	294	31
		2011	3,808	1,444	644	818	8	8	136	99	136	37	256	235	21
		2012	3,835	1,534	541	1,006	10	10	156	151	170	19	312	301	11
		2013	3,814	1,746	574	1,216	9	9	130	62	79	17	285	234	51
05	Mining of coal and lignite	2008	22	816	384	458	6	6	282	123	132	10	94	68	26
		2009	25	864	349	537	*	*	313	116	*	*	117	93	24
		2010	23	917	350	552	6	6	313	107	*	*	103	118	-15
		2011	21	*	*	744	6	7	303	*	126	*	110	107	3

The data is carried forward into **Calculations-Employment(central), Calculations- Employment (low)** and **Calculations- Employment (high)** (105:190).

9.3 Calculations

Calculations are undertaken in the following worksheets: **Calculations-Employment (central), Calculations-Employment (low)** and **Calculations- Employment (high)** sheets separately for each uncertainty scenario**.** Rows 3:190 contain summary of all inputs required for the assessment. The assessment method is comprised of the following steps:

- Step 1: Derive inputs from ABS and BIS data

This step is a measure of labour intensity of the sector and is calculated by dividing total employment costs by total turnover in the sector. Both figures are sourced from the Annual Business Survey published by Office for National Statistics (reference year 2013).

Box 58 Derive inputs from ABS and BIS data

Original data from the annual Business survey from the **Inputs-Employment** sheet are imported into **Calculations-Employment(central), Calculations- Employment (low)** and **Calculations- Employment (high)** (G106:J188) to provide number of enterprises (Column G), total turnover (Column H), total employment – average during the year (Column I) and total employment cost (Column J). Data is imported from the input sheet by using a SUMIFS function using division code and year as variables. The function MAX is used on the years in the source data. This way only the data corresponding to the relevant division code and the latest year is imported. These data are used in Step 1 (Rows 194:295) to calculate the total employment cost per employee (Column J divided by Column I) and labour cost as a shore of total turnover (Column J divided by Column H).

Data for number of businesses (Column K) and number of employers (Column L) are extracted from the data from the department for Business innovation and Skills as presented in the **Inputs-BusinessAfford** sheet. These data are used to calculate the share of businesses that are employers (Column L divided by Column K).

Impact specific fixed inputs				Total employment cost per employee	Labour cost as a share of total turnover	Share of businesses that are employers
Section Code	Section name	Division code	Division name	£k	%	%
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	14	17.0%	37.5%
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	19	20.7%	11.1%
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	14	7.4%	32.4%
C	MANUFACTURING	10	Manufacture of food products	26	12.5%	28.2%
C	MANUFACTURING	11	Manufacture of beverages	43	No data	48.3%
C	MANUFACTURING	13	Manufacture of textiles	20	20.8%	22.8%
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data

The “total employment cost per employee” and the “share of businesses that are employers” are carried forward into Step 2 (rows322:419) of the **Calculations-Employment(central), Calculations- Employment (low)** and **Calculations- Employment (high)** sheets.

▶ Step 2: Calculate absolute impact on employment

This step looks at the absolute impact on employment by calculating two factors: the equivalent number of jobs (Method A) and the potential number of jobs lost (Method B) due to the policy implementation. This step consists of two methods calculated for all uncertainty scenarios in **Calculations-Employment(central), Calculations-Employment (low)** and **Calculations- Employment (high)** sheets**,** (Rows 298:419).

Box 59 Calculate absolute impact on employment

Method A - Equivalent number of jobs affected

Assessment of the equivalent number of jobs is undertaken separately for businesses that are able to pass on costs to their customers (thus face reduced impact on their affordability) and for businesses that are unable to pass on costs. In both cases, the equivalent number of jobs per business is first calculated by dividing the annualised cost of compliance with the policy per business (user input to the model) by the total employment cost per employee (derived for each sector by dividing 2013 values for the total employment costs, by the total employment average during the year; both from the Annual Business Survey. This is calculated in **Columns I and J**, rows 322:418.

The equivalent number of jobs per business (able and unable to pass on cost) is then multiplied by the total number of businesses that are expected to be disproportionally affected by the compliance costs (result of business affordability assessment). The resulting figure provides a high-level estimate of the number of potential jobs that can be lost/gained or moved across sectors as a result of the compliance costs in a given sector. This is calculated in **Columns K and L**, rows 322:418.

Box 59 Calculate absolute impact on employment

Method A

Calculations

Impact specific inputs					ID	Equivalent number of jobs per business unable to pass costs	Equivalent number of jobs per business able to pass costs	Equivalent number of jobs in businesses unable to pass costs per sector/size	Equivalent number of jobs in businesses able to pass costs per sector/size
Section Code	Section name	Division code	Division name	Size		Number	Number	Number	Number
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	No employees	01No emplo	0.51	0.26	3,435	736
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	Micro	01Micro	0.50	0.25	1,609	536
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	Small	01Small	0.50	0.25	120	26
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	Medium	01Medium	0.51	0.26	13	3
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, huntin	Large	01Large	0.51	0.26	2	0
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	No employees	02No emplo	0.32	-	86	-
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	Micro	02Micro	0.32	-	10	-
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	Small	02Small	0.32	-	1	-
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	Medium	02Medium	0.32	-	0	-
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	Large	02Large	0.32	-	No data	No data
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	No employees	03No emplo	0.35	-	67	-
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	Micro	03Micro	0.35	-	30	-
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	Small	03Small	0.35	-	2	-
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	Medium	03Medium	0.35	-	0	-
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	Large	03Large	0.35	-	0	-
C	MANUFACTURING	10	Manufacture of food products	No employees	10No emplo	9.56	1.15	32	1
C	MANUFACTURING	10	Manufacture of food products	Micro	10Micro	193.47	46.43	1,219	92
C	MANUFACTURING	10	Manufacture of food products	Small	10Small	81.24	12.19	1,548	41
C	MANUFACTURING	10	Manufacture of food products	Medium	10Medium	338.00	33.80	13,382	149
C	MANUFACTURING	10	Manufacture of food products	Large	10Large	373.14	37.31	2,519	28
C	MANUFACTURING	11	Manufacture of beverages	No employees	11No emplo	4.30	1.94	No data	No data

Method B – Potential number of jobs lost

Assessment of the number of jobs likely to be lost as a result of increased productions costs of the policy is again undertaken separately for businesses that are able to pass on costs to their customers and for businesses that are unable to pass on costs. In this method it is assumed that all compliance costs of the policy will directly translate into an increase in non-wage labour costs (limitation of this assumption is discussed in section 10.5 below). The elasticity of labour demand to changes in non-wage labour cost of -0.5 is assumed, implying that 1% increase in labour costs will result in 0.5% fall in employment. The figure for elasticity of labour demand has been previously used in DWP (2010) and considering all the limitations described below, has been agreed with Defra to be an approximate but appropriate method to calculate upper bound (worst case scenario) of the impact on employment in the Wider Impacts Model.

In this step, the percentage change in non-wage labour costs is calculated by dividing total annualised cost per business (user input) by total employment cost per business at a size level (derived using ONS (2013) total employment cost and BIS (2013) data on the number of businesses and total number of employees per size of business). As calculated in **Columns P and Q**, rows 322:418 The resulting change in non-wage labour costs is then halved to obtain the potential percentage share in employment. This is calculated in **Columns R and S**, rows 322:418. This share is then applied to the total number employees in a given sector to provide total number of potential jobs lost in each sector affected by the policy. Calculated in **Columns U and V**, rows 322:418.

Box 59 Calculate absolute impact on employment

Method B

Average number of employees per size category	Total employment cost per business at size level	% increase in employment cost per business unable to pass costs	% increase in employment cost per business able to pass costs	% impact on employment per business unable to pass costs	% impact on employment per business able to pass costs	Number of jobs impacted in businesses unable to pass costs per sector (worst case scenario)	Number of jobs impacted in businesses able to pass costs per sector (worst case scenario)
Number	£k	%	%	%	%	Number	Number
1.46	19.92	35%	18%	18%	9%	4,575	980
3.84	52.42	13%	7%	7%	3%	2,143	714
18.39	251.34	3%	1%	1%	1%	160	34
86.15	1,177.44	1%	0%	0%	0%	17	4
-	-	No data	No data	No data	No data	No data	No data
1.08	20.02	30%	0%	15%	0%	390	-
3.64	67.53	9%	0%	4%	0%	44	-
16.67	309.52	2%	0%	1%	0%	4	-
-	-	No data	No data	No data	No data	No data	No data
No data	No data	No data	No data	No data	No data	No data	No data
1.15	16.63	30%	0%	15%	0%	104	-
3.46	50.02	10%	0%	5%	0%	46	-
11.76	169.93	3%	0%	1%	0%	3	-
-	-	No data	No data	No data	No data	No data	No data
-	-	No data	No data	No data	No data	No data	No data
1.18	31.26	809%	97%	405%	49%	57	1
4.42	117.02	4375%	1050%	2188%	525%	2,161	164
22.01	582.56	369%	55%	185%	28%	2,745	73
110.00	2,911.11	307%	31%	154%	15%	23,727	264
1,315.79	34,821.94	28%	3%	14%	1%	4,466	50
No data	No data	No data	No data	No data	No data	No data	No data

9.4 Results-employment and results-summary

The calculation assessment above (section 10.3) provides the outputs of the number of job with significant impact and percentage of jobs with significant impact. The information is fed directly into the **Results-Employment** sheet (Rows 6:91):

- **Impact on employment at division level**

The output presents the impact on employment affected by the policy within affected industry sectors. This is done for low, high and central uncertainty scenario.

Box 60 Policy impact on employment

The final output is presented in the **Results-Employment** sheet which are fed from the **Calculations-Employment(central), Calculations-Employment (low)** and **Calculations- Employment (high)** sheets. Columns C:F refers to the affected industry sectors that are impacted by the implementation of the policy/ measure (inputted from the **Control-Business Afford** sheet) with the associated division code and name as termed in the Standard Industrial Classification (SIC) database. An example can be found below.

Box 60 Policy impact on employment

Impact on employment at division level

Impact specific inputs

Section Code	Section name	Division code	Division name
A	AGRICULTURE, FORESTRY AND FISHIN	01	Crop and animal production, hunting and related service activities
A	AGRICULTURE, FORESTRY AND FISHIN	02	Forestry and logging
A	AGRICULTURE, FORESTRY AND FISHIN	03	Fishing and aquaculture
C	MANUFACTURING	10	Manufacture of food products
C	MANUFACTURING	11	Manufacture of beverages
C	MANUFACTURING	13	Manufacture of textiles
No data	No data	No data	No data
No data	No data	No data	No data
No data	No data	No data	No data
No data	No data	No data	No data
No data	No data	No data	No data

The table calculates two types of expected result consequently of implementing the policy/measure, these are:

- Table 1 (Columns G:S) - This sums the equivalent number of job per sector with significant impact
- Table 2 (Columns U:AF) – The step sums the total number of jobs that could potentially be lost

Uncertainty is carried through the calculations. This is done using two parallel systems:

- Calculations are done for the three uncertainty scenarios (low, medium and high) as provided by the user.
- A qualitative scoring system considers the uncertainty of fixed inputs (and the user inputs if no low and high values are entered).

Table 1

For each of the section and division code and name, the percentage labour cost as a share of total turnover and the total equivalent number of jobs in each affected sector (columns N:P) are presented in the table. The percentage labour cost is calculated in Step 1 of the **Calculations-Employment(central)** sheet and is presented in the table as a measure of labour intensity of the sector. It is calculated by dividing total employment costs by total turnover in the sector. Both figures are sourced from the Annual Business Survey published by Office for National Statistics (reference year 2013). The total equivalent number of jobs is the sum of the "equivalent number of jobs in businesses that are unable to pass the costs on in the particular affected sector" and the "equivalent number of jobs in businesses that are able to pass costs on for in the particular affected sector". The results are also expressed as share of total employment in the division in columns Q:S.

Labour cost as a share of total turnover by industry division	Equivalent number of jobs in businesses unable to pass costs per sector			Equivalent number of jobs in businesses able to pass costs per sector			Total equivalent number of jobs per sector			% of employment in the sector		
	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High
%	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
17%	3,367	3,928	6,313	595	655	631	3,962	4,583	6,945	1%	1%	2%
21%	113	85	187	24	22	32	137	107	219	1%	1%	1%
15%	17	15	21	4	5	2	21	20	23	0%	0%	0%
No data	-	-	-	-	-	-	-	-	-	-	-	-
No data	-	-	-	-	-	-	-	-	-	-	-	-

Table 2

Similarly, for the calculation of the total number of jobs potentially lost (columns AA:AC), the number of jobs potentially lost in each sector that are able or not able to pass costs in each of the sector are summed in the table. They are also presented as percentage of total division employment.

Box 60 Policy impact on employment

Number of jobs potentially lost in businesses unable to pass costs per sector			Number of jobs potentially lost in businesses able to pass costs per sector			Total number of jobs potentially lost (worst case scenario)			Jobs potentially lost (worst case scenario) as % of employment in the sector		
Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High
Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
4,483	5,230	8,406	792	872	841	5,275	6,102	9,247	1%	2%	2%
511	383	843	109	99	145	620	482	988	3%	2%	5%
33	29	40	7	9	4	40	37	44	0%	0%	0%
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

The qualitative uncertainty category associated with the final result can be found in row 93. The results calculated here are fed into **Results-Summary** sheet (Rows 91:98).

The summary of the results for the assessment of employment is presented in **Results-Summary.**

Box 61 Results-Summary for employment

Summary of the results for the impact is presented in **Results-Summary** rows 95:98 where the figures are summed across all sectors. The figure below shows an example of the final summary results drawing the results for the number of equivalent jobs in affected sectors and number of jobs potentially lost in affected sectors from the **Results-Employment** sheet and the **Calculations-Employment(central), Calculations- Employment (low)** and **Calculations- Employment (high)** sheets.

Employment

Employment impact	Scenario			Comments
	Central	Low	High	
Number of equivalent jobs in affected sectors	20,509,914	29,234	67,561	
Potentially affected jobs as a share of total employment in affected sectors (%)	23	0.03	0.08	
Number of jobs potentially lost in affected sectors (worst case scenario)	27,816,222	50,210	127,805	
Potentially lost jobs (worst case scenario) as a share of total employment in affected sectors (%)	32	0.06	0.15	

9.5 Limitations

- Method A calculates “equivalent number of jobs” by comparing the costs of the policy to business with costs of employment. The assessment method does not allow determining whether the resulting jobs affected will be lost/gained or just moved across the sectors. If the cost to business is negative (e.g. benefit per business as a result of a subsidy), the result of the assessment of impacts on employment in terms of “equivalent number of jobs” will show as a benefit (negative values). **Nevertheless the assessment method has not been designed to assess impacts of negative cost, therefore negative costs should not be entered by the user into the Control-BusinessAfford worksheet.**

- Method B is not appropriate to capture any increase in employment. The underlying assumptions made in this method allow only the potential jobs lost to be calculated. Hence if the user inputs negative costs to business in 'Control-BusinessAfford' (e.g. benefit per business as a result of a new subsidy), the impact on employment will not be calculated (results will display as "-").
- The model for this impact can handle a maximum of 91 rows, that is, unique combinations of industry division and sizes. If the user selects divisions and business size categories in excess of 91, the user will need to split the assessment in two different files and merge the outputs separately.
- The model can provide the number of equivalent jobs in affected sectors that would be impacted and an estimation of the number of jobs lost. However, in reality different businesses within the same division and size will have employment impacted to different degrees, which cannot be captured in the model.
- The underlying employment and turnover data from BIS provide information on employment in businesses classed as "No employees". Examining the data demonstrates that employment figures are generally greater than the number of businesses in that category across the sectors. This suggests that businesses in this size category have at least one employee (presumably reflecting self-employment or one or more owners). For that reason assessment of the impact on employment includes impacts on companies categorised as "No employees". If the user of the model wants to exclude these companies from the assessment, zero cost to business for that business size category should be entered in the model.
- There is no evidence of applying the elasticity of labour demand to changes in non-wage labour costs in the context of environmental legislation. Furthermore despite the elasticity figure has been used for the purpose of calculations by GWP in the Impact Assessment of Workplace Pension Reform (2010), results of the consultation supporting the impacts assessment states that only 7% of employers affected would consider absorbing costs through restructuring its workforce. The calculations made in the model do not at any point consider potential responses by businesses to increased productions costs (other than passing costs onto customers which is a user input to the model).
- No consideration is given to displacement and hence the model does not attempt to calculate net employment effects.
- The method does not assess the impacts further down the supply chain for the affected sectors.
- It focuses solely on cost to business and not on potential employment benefits that can be gained in the economy.

10. Method to assess impacts on affordability for individuals

10.1 Overview

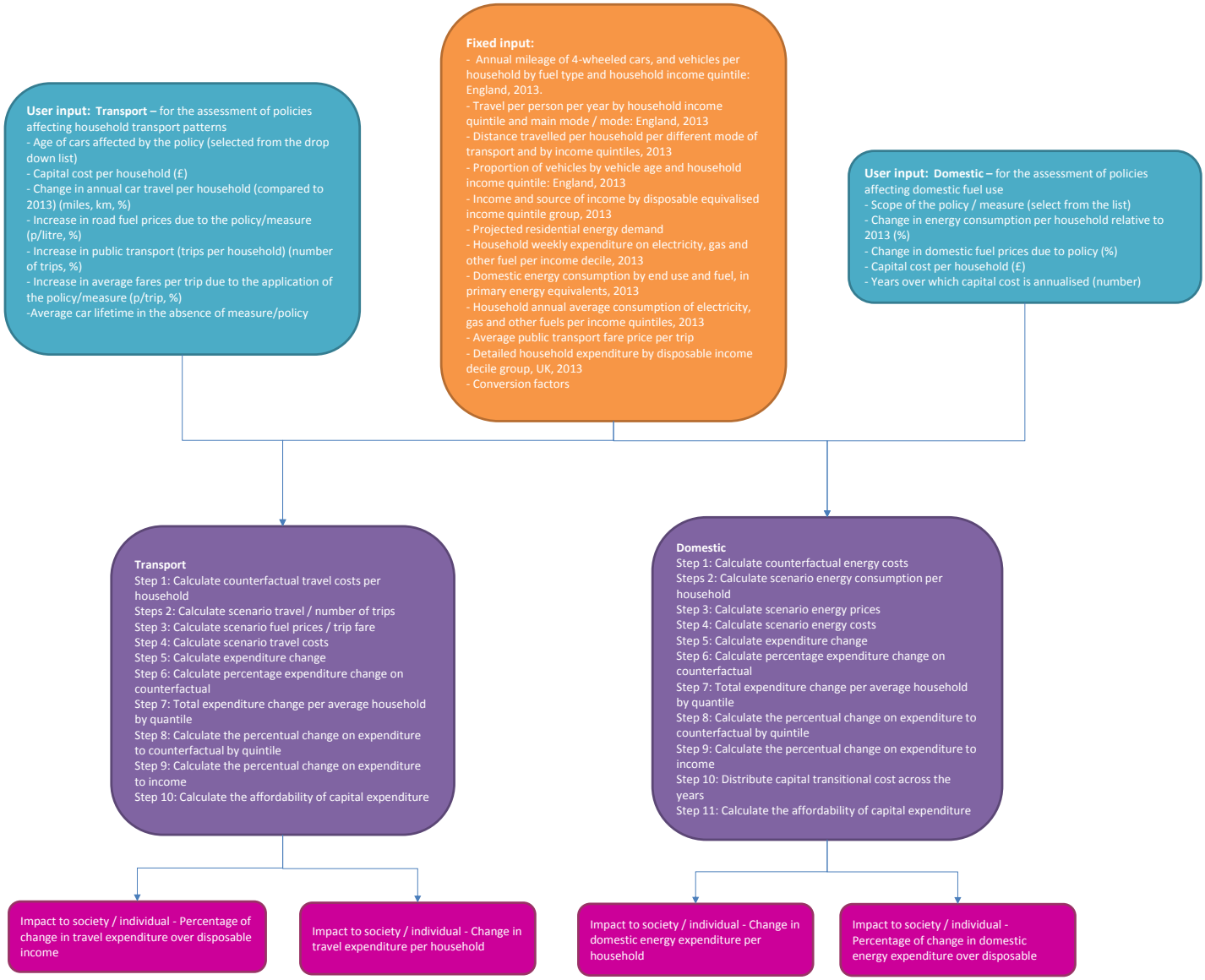
This impact investigates the affordability of a policy to households of different incomes: the direct financial impact of the proposed policy upon a household. It incorporates both the anticipated costs and the benefits of the policy for households in different income quintiles. An understanding of affordability is important to any policy analysis, since the economic implications faced by householders will be central to a policy's economic and social justice, and therefore its public and political acceptability. It is particularly pertinent with regards to air quality policy due to the strong links between air quality and transport, and domestic use of fuels. Transport underlies a wide range of economic activities, and is a fundamental aspect of people's day to day lives. Any policy which alters the costs of mobility has implications on people's access to employment, education and key public services; the extent to which the affordability of mobility is maintained under new policies can therefore have significant social impact, alongside cumulative macro-economic effects. Similarly changes to the technologies used for heating homes, including changes to fuel used and to the overall level of consumption may have important implications on the affordability for households. Understanding the financial implications of air quality policies at household level must therefore be key to any comprehensive impact assessment.

Central to the investigation of affordability is an appreciation of the distributional impacts of a policy. The costs and benefits of a policy will be borne to differing extents by different people, depending upon a variety of characteristics which influence their response to the policy. For example, a policy influencing the price of vehicle fuel may have minimal impact on those who do not own a private vehicle, yet varying impact on car drivers dependent upon both their annual mileage and their capacity to reduce this. The way in which different segments of the population are impacted by a policy is therefore important in order to highlight the full range of potential affordability impacts, and to ensure no disproportionate costs will be borne by more vulnerable sectors of society. This affordability model is therefore designed to calculate the financial impact of a policy for different population segments based upon their annual income.

The potential scope of 'affordability' is very broad, since effects at various different levels of the economy ultimately filter down to the individual. However, for the purposes of this model, this scope has been restricted to cover only direct costs/benefits upon the individual, modelled through looking at changes in consumption levels and the affordability of capital expenditure required to comply with the proposed policy. The method assesses affordability of transport related interventions (e.g. scrappage scheme) and domestic fuel related interventions (e.g. energy efficiency measures) in two separate modules.

Overview of the methodology to calculate this impact is presented in Figure 10.1.

Figure 10.1 Overview of the methodology to assess impacts on affordability for individuals



10.2 Inputs

Inputs used to calculate the impacts on business affordability are summarised in Table 10.1 below. Units, a brief description and the source of data is also detailed. Information regarding

Table 10.1 Summary of all inputs – Affordability for individuals

Input	Units	Comment	Mandatory / Optional	Source
User Inputs (see Control-AffordIndiv)				
For the assessment of policies affecting domestic energy use				
Scope of the policy/ measure	None	For policies affecting domestic sector, tick if the policy affects total household energy, energy used for heating, cooking or hot water or for heating only.	Mandatory	Design of the measure
Change in energy consumption per household for each fuel type due to application of the policy/measure	% or kWh	Select the unit for the input. For each year of the assessment period, enter the expected change in energy consumption per household.	Optional – Only necessary if the measure affects household energy consumption.	Assessment of the measure
Change in domestic fuel prices due to the application of the policy/measure	% or p/kWh	Select the unit for the input. If a policy results in change in fuel prices, enter the expected change per fuel type in each year of the assessment period.	Optional – Only necessary if the measure affects domestic energy prices.	Assessment of the measure
Capital cost per household	£	Enter the expected capital costs per household of achieving compliance with the policy.	Optional – Only necessary if capital costs occur.	Assessment of the measure
Years over which capital cost is annualised	Number	Enter the number of years over which the capital cost is expected to be incurred. For example if there is a transition period, household may be able to spread the capital expenditure across the years of the transition period. If there is no transition period, enter 1.	Optional – Only necessary if capital costs occur.	Assessment of the measure
For the assessment of policies affecting travelling behaviour by households				
Age of cars affected by the policy	None	Select the age categories of cars affected by the policy. This input is required only for the assessment of vehicle scrappage scheme measures.	Optional –Only necessary for assessment of scrappage scheme.	Design of the measure
Average car lifetime in the absence of measure/policy	Number of years	Age at which cars are assumed to be replaced.	Optional – Default: 13 years.	Assessment of the measure
Capital cost per household	£	Enter the expected capital cost per household for petrol and diesel cars (i.e. cost of a petrol or diesel car minus any incentives or subsidies).	Optional – Necessary for assessment of scrappage scheme.	Assessment of the measure

Input	Units	Comment	Mandatory / Optional	Source
Change in annual car travel per household	Miles, km, or %	Select the unit for the input. Enter the change in distance travelled by car per household for petrol, diesel and electric cars.	Optional – Only necessary if the measure affects household energy consumption.	Assessment of the measure
Increase in road fuel prices due to the policy/measure	p/litre or %	Select the unit for the input. Enter the anticipated increase in prices of petrol and diesel.	Optional – Only necessary if the measure affects road fuel prices.	Assessment / design of the measure
Increase in public transport (trips per household)	Number of trips or %	Select the unit for the input. Enter the anticipated change in a number of public transport trips undertaken by bus and rail. The change in number of trips can be entered for no specific area (total), or for London, Inner & outer conurbations, Other urban and rural.	Optional – Only necessary if the measure affects public transport use.	Assessment / design of the measure
Increase in average fares per trip due to the application of the policy/measure	p/trip or %	Select the unit for the input. Enter the anticipated change in a cost of trip by bus and rail. The change in cost of trip can be entered for no specific area (total), or for London, Inner & outer conurbations, Other urban and rural.	Optional – Only necessary if the measure affects public transport prices.	Assessment / design of the measure
Fixed Input (see Inputs-AffordIndividuals)				
Annual mileage of 4-wheeled cars, and vehicles per household by fuel type and household income quintile: England, 2013.	Various	It provides the annual distance travelled by households for petrol and diesel cars in different income quintiles and information on the vehicle ownership per households in different income groups. Based on that data, proportion of vehicle ownership per different income quintiles is calculated in Inputs-AffordIndividuals, Rows 41:59.	N/A	National Travel Survey, Table NTS0902. Provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year.
Travel per person per year by household income quintile and main mode / mode: England, 2013	Various	It provides the distance travelled per person per mode per annum and the number of trips taken per person per mode per annum. This data is used to calculate the average trip length (miles/trip) per income quintile in Inputs-AffordIndividuals, Rows 132:152.	N/A	National Travel Survey, Table NTS0705. Available online https://www.gov.uk/government/statistics/national-travel-survey-2013
Distance travelled per household per different mode of transport and by income quintiles, 2013	Miles	It provides the annual distance travelled per household per annum per different mode types. Note that this input differs from the input above as the results are provided per household rather than per person. This data is used to calculate the number of trips per household per year in Inputs-AffordIndividuals, Rows 155:176.	N/A	National Travel Survey, Table NTS0705 (edit). Provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year.
Proportion of vehicles by vehicle age and household income quintile: England, 2013	%	It provides information on how the ownership of older cars differs by income quintiles.	N/A	Provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year.

Input	Units	Comment	Mandatory / Optional	Source
Income and source of income by disposable equivalised income quintile group, 2013	£	Disposable weekly household income in column G is used in the model.	N/A	ONS, Table 3.11E, Family Spending Survey 2013
Projected residential energy demand	ktoe	This data provides information on the projected future energy demand in the residential sector, per fuel type. This information is used to calculate percentage of the demand for each fuel in future years, compared to demand in 2013. These ratios are calculated in Inputs-AffordIndividuals, Rows 239:244.	N/A	DECC Updated Energy & Emissions Projections - September 2014. Annex F: Final energy demand / Existing Policies Scenario
Household weekly expenditure on electricity, gas and other fuel per income decile, 2013	£ per week	This data provides weekly household expenditure on electricity, gas and other fuel per income decile. Note this covers the total use of fuels (e.g. electricity usage covers appliances, lighting etc. in addition to potential used for heating purposes). This input is used to calculate the household annual average consumption of electricity, gas and other fuels per income quintile in Inputs-AffordIndividuals Rows 297:315.	N/A	Office for National Statistics, Family Spending, 2014 Edition., Table 3.1 - Section 4.4 - Rows 147:150
Domestic energy consumption by end use and fuel, in primary energy equivalents, 2013	Mtoe	This data provides information on the amount of energy used by households for different purposes (e.g. Space heating, water heating, cooking, lighting and appliances). This is used to calculate the share of fuel used for each purpose as a percentage of total energy used (row 284).	N/A	DECC Energy Consumption in the UK (ECUK), 2014 Update, Chapter 3: Domestic data tables, Table 3.02.
Household annual average consumption of electricity, gas and other fuels per income quintiles, 2013	kWh	In Rows 297:315, the annual average consumption of different domestic fuels per household per income quintile is calculated using the following fixed inputs: - Household weekly expenditure on electricity, gas and other fuel per income decile, 2013 - Domestic fuel prices in 2013 from Inputs-GHG row 703 (corresponding to year 2013)	N/A	Derived using other fixed inputs for the purpose of the assessment.
Average public transport fare price per trip	p/trip	The central scenario prices are provided for buses and rail for London, Inner & Outer conurbations, Other urban and rural as well as total GB. Low and high price scenarios are calculated in columns E-H using the uncertainty estimate in cell D332. This uncertainty estimate can be changed by the user for the purpose of each individual assessment.	N/A	Derived using costs included in NTM data, provided by DfT specifically for this project
Detailed household expenditure by disposable income decile group, UK, 2013	£	Total expenditure per average household in each income decile on purchasing of vehicles and operation of personal transport.	N/A	Office for National Statistics, Family Spending, 2014 Edition, Table 3.1

Input	Units	Comment	Mandatory / Optional	Source
Conversion factors	Multiple	These are conversion factors used in calculations for the impact to change from one unit to another.	N/A	None

User inputs (Control- AffordIndiv)

User inputs are entered in the sheet **Control-AffordIndiv**. In order to account for uncertainty in a quantitative manner, the user should enter inputs for three scenarios: Central, Low and High. Alternatively if a single set of inputs is available the user should input it under the Central scenario row only and select the qualitative uncertainty score in column AN.

The **user inputs** required to calculate the impact of affordability on individuals are divided into two main categories:

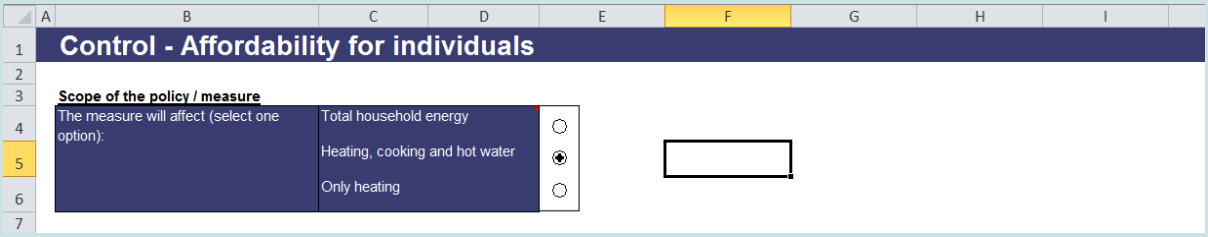
- **Domestic –** for the assessment of policies affecting domestic fuel use (**Control-AffordIndiv**, Rows 2:58). This requires the following user inputs:
  - Scope of the policy/ measure (select from the list).
  - Change in energy consumption per household relative to 2013 (%, kWh).
  - Change in domestic fuel prices due to policy (%, p/kWh).
  - Capital cost per household (£).
  - Years over which capital cost is annualised (number).
- **Transport –** for the assessment of policies affecting household transport patterns (**Control-AffordIndiv**, Rows 59:175). This requires the following user inputs:
  - Age of cars affected by the policy (selected from the drop down list).
  - Average car lifetime in the absence of measure/ policy.
  - Capital cost per household (£).
  - Change in annual car travel per household (compared to 2013) (miles, kms, %).
  - Increase in road fuel prices due to the policy/measure (p/litre, %).
  - Annual increase in public transport (trips per household) (number of trips, %).
  - Increase in average fares per trip due to the application of the policy/measure (p/trip, %).

"Domestic" - user inputs for the assessment of policies affecting domestic fuel use

- **Control-AffordIndiv** "*Scope of the policy / measure*" (Rows 4:6): The user needs to select what part of energy used per households will be affected by the policy. For example, energy efficiency measures such as insulation would affect the consumption of fuels used for heating purposes only, policies encouraging switch between different types of domestic fuels would affect the consumption of fuels for heating, cooking and hot water; while policies encouraging greater uptake of microgeneration (e.g. PV) are likely to affect total household energy consumption (including energy used for powering domestic appliances and lighting). The user is required to tick relevant category in column E. Only one category can be selected for the assessment.

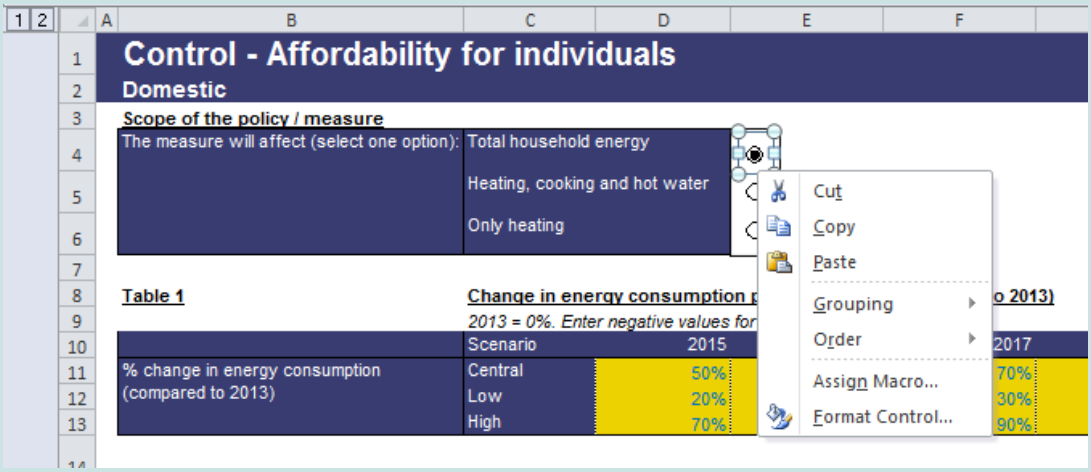
Box 62 Scope of the policy assessed

Scope of the policy assessed is to be selected from the option button in **Control-AffordIndiv** "Scope of the policy/measure" (rows 4:6). There is no uncertainty assessment associated with this input.

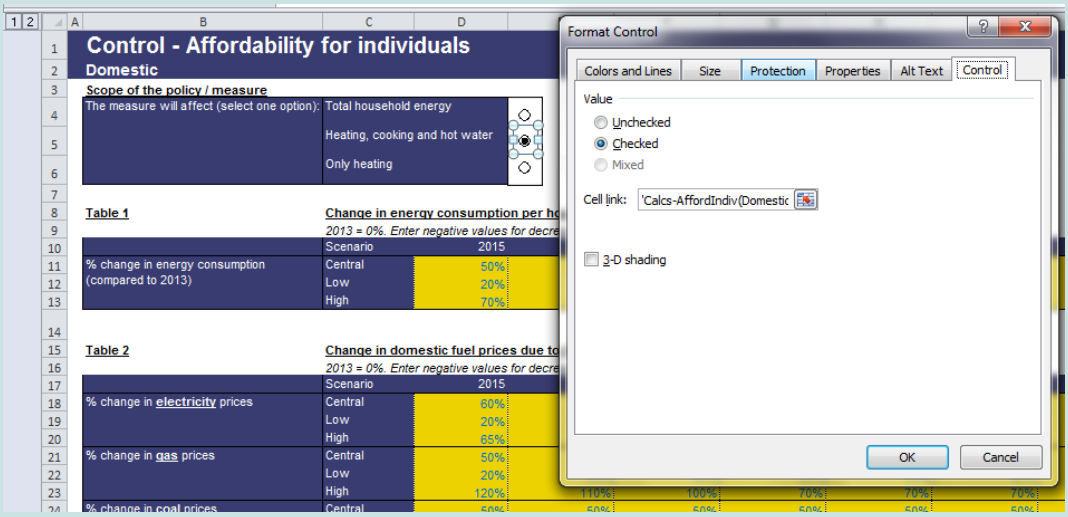


The selection buttons feeds information to **Calcs-AffordIndiv(Domestic)** cell D7, which in turn brings the right proportion of fuels affected to **Calcs-AffordIndiv(Domestic)** Rows 71:74. The source of this data is detailed in Box 79.

If the link to which the selection button feeds to need to be updated (e.g. as part of model revision), click right on the select button and from the drop down list select "Format Control".



Go to "Control" tab and update the cell reference under "Cell link".



- **Control- AffordIndiv** *Table 1* "*Change in energy consumption per household relative to 2013*" (Rows 8:24): The user is required to input the expected change in energy consumption per household compared to 2013 reference year.

Box 63 Change in the overall energy consumption per household for each fuel type

The input should be provided in **Control- AffordIndiv** *Table 1* "*Change in energy consumption per household for each fuel type due to application of the policy / measure*" (Rows 8:24).

User needs to select the input units from the drop down menu in cell C10, choosing between % change or kWh. Depending on the unit selected, further instructions are provided in cell D10 (e.g. enter inputs as numbers between 0 and 100, not in excel % format).

After selecting the units, user needs to fill Table 1 (rows 13:24) as appropriate. Four input sections are provided, one for each fuel type (electricity, gas, coal and oil). If the measure/policy is only affecting some fuels, rows for fuels not affected must be left blank. Quantitative estimates can be provided for central, low, and high uncertainty scenarios in individual rows. Qualitative uncertainty score can be selected in column AN.

Table 1 **Change in energy consumption per household for each fuel type due to application of the policy/mesure** (change in

Unit: % *Enter percentages as numbers between 1 and 100*

Enter negative values for decreases

	Scenario	2015	2016	2017	2018	2019	2020	2021	2022
change in **electricity** consumption	Central	10	10	10	10	10	10	10	10
	Low	5	5	5	5	5	5	5	5
	High	20	20	20	20	20	20	20	20
change in **gas** consumption	Central								
	Low								
	High								
change in **coal** consumption	Central								
	Low								
	High								
change in **oil** consumption	Central								
	Low								
	High								

The information is fed trough to **Calcs-AffordIndiv(Domestic)** Rows 12:23.

- **Control- AffordIndiv** *Table 2* "*Change in domestic fuel prices due to the application of the policy/measure*" (Rows 26:42): The user is required to select the input unit for the change in prices of domestic fuels as a result of the policy. The change can be input for electricity, gas, coal and oil. Three uncertainty scenarios can be run if the user completes the table with quantitative estimates for central, low and high scenario. Alternatively (or complementary) a qualitative uncertainty score could be selected in column AN.

Box 64 Change in the overall energy consumption per household

The input should be provided in **Control- AffordIndiv** *Table 2* "*Percentage change in domestic fuel prices due to the application of the policy/measure*" (Rows 26:42). User needs to select the input units from the drop down menu in cell C28, choosing between % change or p/kWh. Depending on the unit selected, further instructions are provided in cell D28.

After selecting the units, user needs to fill Table 2 (rows 30:42) as appropriate. Four input sections are provided, one for each fuel type (electricity, gas, coal and oil). If the measure/policy is only affecting some fuels, rows for fuels not affected must be left blank. Quantitative estimates could be provided for central, low, and high uncertainty scenarios in individual rows. Qualitative uncertainty score can be selected in column AN.

Table 2 **Change in domestic fuel prices due to the application of the policy/measure** (change in p/kW

Unit: % *Enter percentages as numbers between 1 and 100*

Enter negative values for decreases

	Scenario	2015	2016	2017	2018	2019	2020
change in **electricity** prices	Central	10	10	10	10	10	10
	Low	5	5	5	5	5	5
	High	20	20	20	20	20	20
change in **gas** prices	Central	10	10	10	10	10	10
	Low	5	5	5	5	5	5
	High	20	20	20	20	20	20
change in **coal** prices	Central	100	100	100	100	100	100
	Low	5	5	5	5	5	5
	High	20	20	20	20	20	20
change in **oil** prices	Central	10	10	10	10	10	10
	Low	5	5	5	5	5	5
	High	20	20	20	20	20	20

The information is fed trough to **Calcs-AffordIndiv(Domestic)** Rows 28:39.

- **Control- AffordIndiv** *Table 3* "*Capital cost per household - Unit: £*" (Rows 44:49): The user is required to input the expected capital cost of compliance with the policy per household. Three quantitative scenarios are required. Alternatively a central estimate can be provided with the qualitative uncertainty score provided in column E.
- **Control- AffordIndiv** *Table 4* "*Years over which capital cost is annualised*" (Rows 51:56): The user is required to input the number of years over which the capital costs of compliance with the policy will be incurred. For example if policy assumes a transition period of a number of years, the households may incur part of the total capital cost each year (e.g. by saving in years of transition or by repaying the loan).

Box 65 Capital cost per household and year in which the capital costs are incurred

The input should be provided in **Control- AffordIndiv** *Table 3* "*Capital cost per household - Unit: £*" (Rows 46:49). Quantitative estimates could be provided for different uncertainty scenarios. A qualitative uncertainty score can also be selected in column AN.

Table 3 **Capital cost per household - Unit: £**

	Scenario	2020	Qualitative uncertai	Score
Capital cost per household (£)	Central	2,000	not used	1
	Low	1,500		
	High	3,000		

The information is fed through to **Calcs-AffordIndiv(Domestic)** Rows 80:82.

In **Control- AffordIndiv** *Table 4* "*Years over which capital cost is annualised*" (Rows 54:56) enter the number of years over which the capital costs per household will be incurred.

Table 4 **Years over which capital cost is annualised**

	Scenario		Qualitative uncertai	Score
Years	Central	3	not used	1
	Low	1		
	High	5		

The information is fed through to **Calcs-AffordIndiv(Domestic)** Rows 87:89.

"Transport" - user inputs for the assessment of policies affecting travelling patterns of a household

- **Control- AffordIndiv** *Table 5* "*Age of cars affected by the policy*" (Rows 61:64): The user is required to select the age of cars that will be affected by the policy assessed. This input is relevant to assessment of policies such as vehicle scrappage scheme. This input is required to account for the fact that households in different income quintiles own cars of different age.

Box 66 Capital cost per household and years over which capital cost is annualised

The input should be provided in **Control- AffordIndiv** *Table 6* "*Capital cost per household*" (Rows 68:76). Capital costs should be provided for petrol cars (Rows 71:73) and diesel cars (Rows 74:76).

Table 6 **Capital cost per household (i.e. cost of a car) - Unit: £**

	Scenario	Measure applies in 2020	Qualitative un	Score
Petrol car	Central	10,000	not used	1
	Low	8,000		
	High	13,000		
Diesel car	Central	12,000	not used	1
	Low	9,000		
	High	20,000		

The information is fed trough to **Calcs-AffordIndiv(Transport)** Row 42:47.

- **Control- AffordIndiv** *Table 6*"*Capital cost per household (i.e. cost of a car)*" (Rows 68:76): The user is required to input the expected capital cost of compliance with the policy per household (i.e. price of a petrol or diesel car). This input is relevant to the policies that may encourage households to

purchase new vehicles (i.e. scrappage schemes). Costs should be provided in pounds for petrol and diesel cars. Three quantitative scenarios are required. Qualitative uncertainty score can be selected in column E.

Box 67 Change in annual car travel per household

The input should be provided in **Control- AffordIndiv** *Table 8* "*Change in annual car travel per household*" (Rows 83:91). Change in travel by car should be input for petrol (Rows 83:85), diesel (86:88) and electric cars (89:91).

Unit: % *Enter percentages as numbers between 1 and 100*

	Scenario	2015	2016	2017	2018	2019
Petrol car	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700
Diesel car	Central	500	500	500	500	500
	Low	-200	-500	200	200	200
	High	700	700	700	700	700
Electric car	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700

The information is fed trough to **Calcs-AffordIndiv(Transport)** Row 81:93.

- **Control- AffordIndiv** *Table 7* "*Change in annual car travel per household*" (Rows 78:91): The user first selects the unit in which the input will be required in cell C80. Input can be provided in either miles, kilometres or as a percentage. Change in annual car travel per household should be entered for diesel, petrol and electric car. If % change is selected as unit, rows for electric cars will turn grey and the inputs will not be considered as it is assumed no electric cars were commercially available in the counterfactual. If the travel by car decreases as a result of the policy the inputs should be entered as negative values.

Box 68 Change in annual car travel per household

The input should be provided in **Control- AffordIndiv** *Table 8* "*Change in annual car travel per household*" (Rows 83:91). Change in travel by car should be input for petrol (Rows 83:85), diesel (86:88) and electric cars (89:91).

Unit: % *Enter percentages as numbers between 1 and 100*

	Scenario	2015	2016	2017	2018	2019
Petrol car	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700
Diesel car	Central	500	500	500	500	500
	Low	-200	-500	200	200	200
	High	700	700	700	700	700
Electric car	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700

The information is fed trough to **Calcs-AffordIndiv(Transport)** Row 81:93.

- **Control- AffordIndiv** *Table 8* "*Increase in road fuel prices due to the policy/measure*" (Rows 93:103): The user first selects the unit in which the input will be provided in cell C80. Input can be provided in either p/litre or as a percentage. Increase in road fuels has to be entered separately for petrol and

diesel vehicles. If the cost of road fuel decreases as a result of the policy the inputs should be entered as negative values.

Box 69 Increase in road fuel prices due to the policy/measure

The input should be provided in **Control- AffordIndiv** *Table 8* "*Increase in road fuel prices due to the policy/measure*" (Rows 98:103). Change in fuel cost should be entered for petrol (Rows 98:100) and diesel (101:103).

Unit: p/litre *2013 prices*

	Scenario	2015	2016	2017	2018	2019
Petrol	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700
Diesel	Central	500	500	500	500	500
	Low	200	200	200	200	200
	High	700	700	700	700	700

The information is fed trough to **Calcs-AffordIndiv(Transport)** Rows 112:117.

- **Control- AffordIndiv** *Table 9 "Annual increase in public transport (trips per household)"* (Rows 105:139): The user first selects the unit in which the input will be provided in cell C107. Input can be provided in either in "Number of trips" or as a percentage. Increase in public transport trips needs to be entered separately for buses and rail. It must be entered as a total change using average UK assumptions. Further improvements can be made in the model in order to specify inputs by area but this is currently not operational. If the number of trips decreases as a result of the policy the inputs should be entered as negative values.

Box 70 Increase in public transport (trips per household)

Control- AffordIndiv *Table 9* "*Annual increase in public transport (trips per household)*" (Rows 110:112 and 125:127). Increase in public transport trips needs to be entered separately for buses (rows 110:112) and rail (Rows 125:127). The tool currently uses UK level background data. As there is potential for improvement in the model regarding adding data at regional level, collapsed rows have been added although they are not operational. If there is a decrease in the use of public transport, the inputs should be entered as negative values.

105 **Table 9** **Annual increase in public transport (trips per household)** *Enter negative*

106

107 Unit: % *Enter percentages as numbers between 1 and 100*

108

		109 Scenario	2015	2016	2017	2018	2019
110	Buses (total)	Central	5	5	5	5	5
111		Low	3	3	3	3	3
112		High	7	7	7	7	7
125	Rail (total)	Central	5	5	5	5	5
126	(including Underground, metros and trams)	Low	3	3	3	3	3
127		High	7	7	7	7	7

The information is fed trough to **Calcs-AffordIndiv(Transport)** Rows 174:191.

- **Control- AffordIndiv** *Table 10* "*Increase in average fares per trip due to the application of the policy/measure*" (Rows 141:175): The user first selects the unit in which the input will be provided in cell C143. Input can be provided in either "p/trip" or as a percentage. Increase in fares of public transport trips needs to be entered separately for buses and rail. It must be entered as a total change using average UK assumptions. Further improvements can be made in the model in order to specify

inputs by area but this is currently not operational. If the cost of trip fuel decreases as a result of the policy the inputs should be entered as negative values.

Box 71 Increase in average fares per trip due to the application of the policy/measure

Control- AffordIndiv *Table 10* "Increase in average fares per trip due to the application of the policy/measure)" (Rows 146:148 and 161:163). Increase in public transport trips needs to be entered separately for buses (Rows 146:148) and rail (Rows 161:163 The tool currently uses UK level background data. As there is potential for improvement in the model regarding adding data at regional level, collapsed rows have been added although they are not operational. If there is a decrease in the public transport fares, the inputs should be entered as negative values.

141	**Table 10**		**Increase in average fares per trip due to the application of the p** *Enter negative*				
142							
143	Unit:		p/trip	*2013 prices*			
144							
145		Scenario	2015	2016	2017	2018	2019
146	Buses	Central	10	10	10	10	10
147		Low	5	5	5	5	5
148		High	15	15	15	15	15
161	Rail (including Underground, metros and trams)	Central	10	10	10	10	10
162		Low	5	5	5	5	5
163		High	15	15	15	15	15

The information is fed trough to **Calcs-AffordIndiv(Transport)** Rows 244:261.

Fixed inputs

Inputs-AffordIndividuals worksheet contains the fixed inputs required for the assessment of policies affecting domestic fuel use and travelling patterns. **Fixed inputs** required to calculate the impact are:

- Annual mileage of 4-wheeled cars, and vehicles per household by fuel type and household income quintile: England, 2013.
- This data is based on the National Travel Survey, Table NTS0902. It has been provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year. Therefore updating this information with future results of the survey will only be possible if this data is requested again from the DfT.
- It should be noted that NTS covers England only. It is however considered the best available information for the model and is used as a proxy for whole of the UK.

Box 72 Annual mileage of 4-wheeled cars, and vehicles per household by fuel type and household income quintile: England, 2013

It provides the annual distance travelled by households for petrol and diesel cars in different income quintiles. The source also provides information on the vehicle ownership per households in different income groups (columns H:K).

Annual mileage of 4-wheeled cars, and vehicles per household by fuel type and household income quintile: England, 2013.

	Annual mileage (miles)				Vehicles per household			
	Petrol	Diesel	All 4-wheeled cars	Unweighted sample size (all cars)	Petrol	Diesel	-wheeled cars	Unweighted sample size (households)
Lowest real income level	5,600	8,300	6,400	867	0.38	0.15	0.53	1,583
Second level	6,100	9,500	7,000	1,290	0.58	0.22	0.79	1,609
Third level	6,300	9,200	7,100	1,561	0.72	0.26	0.98	1,592
Fourth level	7,200	11,200	8,500	1,841	0.81	0.37	1.18	1,558
Highest real income level	7,300	12,700	9,300	1,790	0.76	0.43	1.19	1,480
All income levels	6,700	10,700	7,900	7,349	0.65	0.29	0.93	7,822

Based on that data, proportion of vehicle ownership per different income quintiles is calculated in **Inputs-AffordIndividuals**, Rows 41:59.

Proportion of petrol to diesel vehicles ownership by income quintile, 2013

	Petrol	Diesel
Lowest real income level	71%	29%
Second level	73%	27%
Third level	74%	26%
Fourth level	68%	32%
Highest real income level	64%	36%
All income levels	69%	31%

This data feeds into **Calcs-AffordIndiv(Transport)** Rows 23:34.

- **Travel per person per year by household income quintile and main mode / mode: England, 2013:** This data is based on the National Travel Survey, Table NTS0705. It is part of the official statistics published by Department for Transport each year. For future updates the data is expected to be available online at the gov.uk portal. It should be noted that NTS covers England only. It is however considered the best available information for the model and is used as a proxy for whole of the UK.

Box 73 Travel per person per year by household income quintile and main mode / mode: England, 2013

It provides the distance travelled per person per mode per annum and the number of trips taken per person per mode per annum.

Travel per person per year by household income quintile and main mode / mode: England, 2013

	Real household income quintile					
	Lowest real income level	Second level	Third level	Fourth level	Highest real income level	All income levels
Trips per person per year by main mode:						
Walk	253	190	193	189	187	203
Bicycle	12	17	14	15	14	14
Car / van driver	203	328	410	478	496	380
Car / van passenger	180	228	227	221	192	210
Other private transport[1]	7	13	10	10	10	10
Local and non-local buses	116	68	59	37	33	63
Rail[2]	20	20	22	27	61	30
Other public transport[3]	17	13	10	10	14	13
All modes	808	877	945	987	1,008	923
Distance (miles) per person per year by mode:						
Walk	216	169	181	170	199	187
Bicycle	28	43	48	60	70	49
Car / van driver	1,296	2,220	3,028	4,355	5,526	3,235
Car / van passenger	1,447	1,692	1,938	2,065	2,229	1,865
Other private transport[1]	78	147	223	160	164	154
Local and non-local buses	524	381	342	211	179	331
Rail[2]	391	384	506	617	1,427	650
Other public transport[3]	73	75	69	76	286	113
All modes	4,053	5,110	6,334	7,714	10,079	6,584
Unweighted sample size:						
individuals	3,398	3,361	3,243	3,287	2,903	16,192
trips ('000s)	50	54	56	60	54	274
stages ('000s)	56	58	61	65	62	302

This data is used to calculate average trip length (miles/trip) per income quintile in **Inputs-AffordIndividuals**, Rows 136:143.

Average trip length (miles/trip), 2013

	Real household income quintile					
	Lowest real income level	Second level	Third level	Fourth level	Highest real income level	All income levels
Walk	0.86	0.89	0.94	0.90	1.06	0.92
Bicycle	2.40	2.52	3.54	3.90	4.90	3.43
Car / van driver	6.37	6.76	7.38	9.10	11.14	8.51
Car / van passenger	8.06	7.43	8.55	9.33	11.58	8.90
Other private transport[1]	11.21	11.61	22.60	16.51	15.65	15.50
Local and non-local buses	4.51	5.62	5.82	5.66	5.47	5.22
Rail[2]	19.34	18.98	22.83	22.75	23.41	22.01
Other public transport[3]	4.42	5.57	6.53	7.86	20.73	8.79

This data is feeding into calculation of “Number of trips per household per year” **Inputs-AffordIndividuals** Rows 155:176.

- Distance travelled per household per different mode of transport and by income quintiles, 2013.
- This data is based on the National Travel Survey, Table NTS0705, however unlike the previous input described above it provides data per household, rather than by person. It has been provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year. Therefore updating this information with future results of the survey will only be possible if this data is requested again from the DfT.

Box 74 Distance travelled per household per different mode of transport and by income quintiles, 2013

It provides the annual distance travelled per household per annum per different mode types.

Distance travelled per household per different mode of transport and by income quintiles, 2013

	Real household income quintile					
	Lowest real income level	Second level	Third level	Fourth level	income level	levels
Distance (miles) per household per year by stage mode:						
Walk	543	413	433	417	444	450
Bicycle	71	104	116	147	155	118
Car / van driver	3,250	5,417	7,243	10,654	12,302	7,774
Car / van passenger	3,630	4,130	4,635	5,051	4,962	4,482
Other private transport[1]	196	358	533	392	366	369
Local and non-local buses	1,315	930	817	516	398	795
Rail[2]	980	936	1,209	1,508	3,177	1,562
Other public transport[3]	184	182	164	187	636	271
All modes	10,169	12,471	15,150	18,870	22,440	15,821
Unweighted sample size:						
households	1,362	1,407	1,396	1,365	1,300	6,830
trips ('000s)	50	54	56	60	54	274
stages ('000s)	56	58	61	65	62	302

This data is used to calculate the number of trips per household per year in **Inputs-AffordIndividuals**, Rows 155:176. In this calculation the distance travelled per household per annum is divided by the average distance travelled per mode (calculated in Rows 160:167).

Number of trips per household per year, 2013

	Real household income quintile					
	Lowest real income level	Second level	Third level	Fourth level	Highest real income level	All income levels
Number of trips per household per year (calculated)						
Walk	635	463	462	461	417	488
Bicycle	30	41	33	38	32	35
Car / van driver	510	801	981	1,170	1,104	913
Car / van passenger	451	556	542	541	428	504
Other private transport[1]	18	31	24	24	23	24
Local and non-local buses	291	165	141	91	73	152
Rail[2]	51	49	53	66	136	71
Other public transport[3]	42	33	25	24	31	31

- **Proportion of vehicles by vehicle age and household income quintile: England, 2013:** This data is based on the results of the National Travel Survey. It has been provided on request from the NTS team at Department for Transport for the purpose of this project. This information is not part of the NTS official data published by the DfT each year. Therefore updating this information with future results of the survey will only be possible if this data is requested again from the DfT.

Box 75 Proportion of vehicles by vehicle age and household income quintile: England, 2013

It provides information on how the ownership of older cars differs by income quintiles.

Proportion of vehicles by vehicle age and household income quintile: England, 2013

	Percentage								
	Up to 2 years	years	years	years	years	years	Over 13 years	All ages	sample size
Lowest real income level	10	9	10	15	17	21	18	**100**	1,087
Second level	10	10	12	14	17	20	16	**100**	1,569
Third level	11	11	12	15	17	20	14	**100**	1,928
Fourth level	13	14	13	16	16	18	12	**100**	2,344
Highest real income level	17	17	15	15	14	12	9	**100**	2,273
All households	13	13	13	15	16	18	13	**100**	9,201

The data is fed through to **Calcs-AffordIndiv(Transport)** Rows 7:13.

- **Income and source of income by disposable equivalised income quintile group, 2013.** This data is sourced from the Office for National Statistics, Table 3.11E, Family Spending Survey 2014. It is part of statistical release published each year and is expected to be published in the same format in the future years.
- Note that there may be differences in the income quintiles used in the National Travel Survey and the Family Spending Survey. However this is considered the best available information as the NTS does not contain the data on average income per income quintile. Should the information on the average income per income group be available from the NTS in the future, the average income be income group should be updated with these figures. At this stage, it is considered acceptable to use the income data together with the NTS data because both surveys aim to provide representative set of results and are based on the same year (2013). This approach has been approved by a statistician consulted on this matter at the Department for Transport.

Box 76 Income and source of income by disposable equivalised income quintile group, 2013

The table provides information on the weekly household income per different income quintile groups. The weekly income is provided in two categories: disposable (column G) and gross (column H). For the purpose of assessing affordability on individuals, the disposable income figures are used as it is considered a better measure of what is likely to be affordable for households. Information on the source of income in columns I:N is not used in the model.

Income and source of income by disposable equivalised income quintile group, 2013

	Weighted number of house-holds	Number of house-holds in the sample	Weekly household income	
			Dispo-sable	Gross
Disposable equivalised income quintile group	(000s)	Number	£	£
Lowest twenty per cent	5,370	1,030	195	202
Second quintile group	5,370	1,060	376	410
Third quintile group	5,370	1,050	528	605
Fourth quintile group	5,370	1,030	721	868
Highest twenty per cent	5,360	980	1,252	1,609

Based on the weekly figures, the average annual disposable income per household per income quintile is calculated in columns P:Q. This assumes 52 weeks in a year.

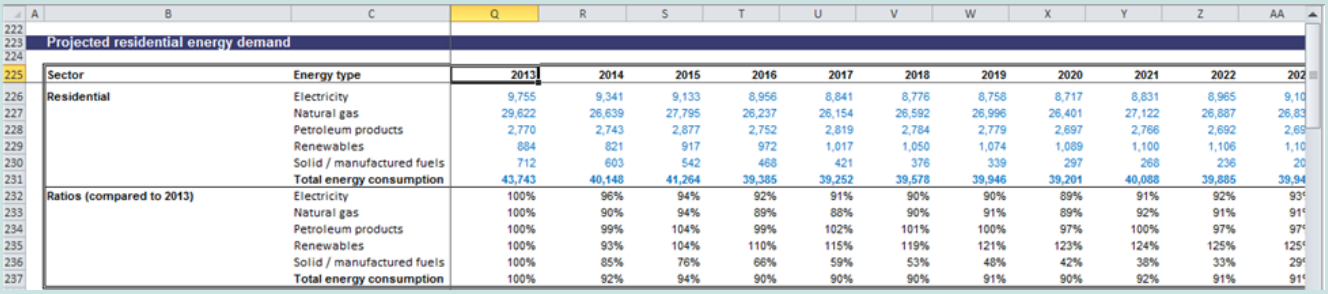
Annual household income	
Disposable	Gross
£	£
10,140	10,504
19,552	21,320
27,456	31,460
37,492	45,136
65,104	83,668

This feeds into **Calcs-AffordIndiv(Domestic)** Rows 92:100 and **Calcs-AffordIndiv(Transport)** Rows 276:285.

- **Projected residential energy demand.** This data is sourced from DECC Updated Energy & Emissions Projections - September 2014. Annex F: Final energy demand/ Existing Policies Scenario. These are official projections expected to be published by DECC at least annually. The table is set out in the same format as the original source of data.

Box 77 Projected residential energy demand

This data provides information on the projected future energy demand in the residential sector, per fuel type. This information is used to calculate percentage of the demand for each fuel in future years, compared to demand in 2013. These ratios are calculated in **Inputs-AffordIndividuals**, Rows 237:242.



Projected residential energy demand

Sector	Energy type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	202
Residential	Electricity	9,755	9,341	9,133	8,956	8,841	8,776	8,758	8,717	8,831	8,965	9,10
	Natural gas	29,622	26,639	27,795	26,237	26,154	26,592	26,996	26,401	27,122	26,887	26,83
	Petroleum products	2,770	2,743	2,877	2,752	2,819	2,784	2,779	2,697	2,766	2,692	2,69
	Renewables	884	821	917	972	1,017	1,050	1,074	1,089	1,100	1,106	1,10
	Solid / manufactured fuels	712	603	542	468	421	376	339	297	268	236	20
	Total energy consumption	43,743	40,148	41,264	39,385	39,252	39,578	39,946	39,201	40,088	39,885	39,94
Ratios (compared to 2013)	Electricity	100%	96%	94%	92%	91%	90%	90%	89%	91%	92%	93
	Natural gas	100%	90%	94%	89%	88%	90%	91%	89%	92%	91%	91
	Petroleum products	100%	99%	104%	99%	102%	101%	100%	97%	100%	97%	97
	Renewables	100%	93%	104%	110%	115%	119%	121%	123%	124%	125%	125
	Solid / manufactured fuels	100%	85%	76%	66%	59%	53%	48%	42%	38%	33%	29
	Total energy consumption	100%	92%	94%	90%	90%	90%	91%	90%	92%	91%	91

This feeds into **Calcs-AffordIndiv(Domestic)** Rows 50:57.

- **Household weekly expenditure on electricity, gas and other fuel per income decile, 2013.** This data is sourced from Office for National Statistics, Family Spending, 2014 Edition, Table 3.1 - Section 4.4 - Rows 147:150. The same limitation of using this data in combination with other inputs applies (as described above).

Box 78 Household weekly expenditure on electricity, gas and other fuel per income decile, 2013

This data provides weekly household expenditure on electricity, gas and other fuel per income decile. Note this covers the total use of fuels (e.g. electricity usage covers appliances, lighting etc. in addition to potential used for heating and hot water purposes).

Household weekly expenditure on electricity, gas and other fuel per income decile, 2013

	Lowest ten per cent	Second decile group	Third decile group	Fourth decile group	Fifth decile group	Sixth decile group
Electricity, gas and other fuels[3]	20	22	22	25	25	27
Electricity	10	11	11	12	12	12
Gas	9	10	11	12	12	12
Other fuels	2	2	1	1	1	2

This input is used to calculate household annual average consumption of electricity, gas and other fuels per income quintile in **Inputs-AffordIndividuals** Rows 297:315 (see box 80).

- **Domestic energy consumption by end use and fuel, in primary energy equivalents, 2013.** This data is based on the DECC Energy Consumption in the UK (ECUK), 2014 Update, Chapter 3: Domestic data tables, Table 3.02. It is expected to be published in the same format in future years and be available online.

Box 79 Domestic energy consumption by end use and fuel, in primary energy equivalents, 2013

This data provides information on the amount of energy used by households for different purposes (e.g. Space heating, water heating, cooking, lighting and appliances). This is used to calculate (in row 284) the share of fuel used for each purpose as a percentage of total energy used.

Domestic energy consumption by end use and fuel, in primary energy equivalents, 2013

	Solid fuels				
	Space	Water	Cooking	Lights and appliances	Total domestic
2013	5.0	1.3	0.7	9.4	16.4
Share of each fuel type by end use (calculated)	30%	8%	4%	58%	100%

This input is required to understand what share of total household expenditure is associated with overall energy consumption, provision of heating and hot water, provision of heating. This data is fed into **Calcs-AffordIndiv(Domestic)** rows 62:65. The difference in domestic coal and petroleum consumption (cells G281 and M281) is also used to calculate household annual average consumption of these fuels per income quintile in **Inputs-AffordIndividuals** Rows 297:315 (see box 80)

- Household annual average consumption of electricity, gas and other fuels per income quintiles, 2013. This data is calculated based on a range of other fixed inputs. These calculations should not be changed and will update automatically when the underlying fixed inputs are updated.

Box 80 Household annual average consumption of electricity, gas and other fuels per income quintiles, 2013

In Rows 297:315, the annual average consumption of different domestic fuels per household per income quintile is calculated using the following fixed inputs:

- Household weekly expenditure on electricity, gas and other fuel per income decile, 2013. Average weekly expenditure is calculated first for each two deciles (rows 261:264) in order to obtain a representative figure per income quintile. This is then re-calculated into annual expenditure by fuel type assuming 52 weeks in a year.

- Annual expenditure is then divided by domestic fuel prices in 2013 from **Inputs-GHG** row 703 (corresponding to year 2013 for which the expenditure data is available). Future updates of the inputs must ensure that the formula is still looking at the right year.

- As fuel prices are expressed in p/kWh and expenditure in £, the equation is multiplied by 100.

- Because Household weekly expenditure does not differentiate between oil and coal (these being grouped under "other fuels"), the proportional consumption of these fuels from **Inputs-AffordIndividuals** cells G281 and M281 is used to weight them.

- Burning oil prices are given in litres so a conversion factor has been applied to provide data in kWh (multiplied by **Inputs-GHG** cell I415)

Household annual average consumption of electricity, gas and other fuels per income quintiles, 2013

	Lowest quintile	Second quintile	Third quintile	Fourth quintile	ghest quintile
Electricity	3381	3716	3967	4235	4938
Gas	10041	12028	12708	13911	16368
Coal	1290	846	1330	1612	3144
Burning oil	208	137	215	260	508
Other fuels	1498	983	1545	1872	3651

This data feeds into **Calcs-AffordIndiv(Domestic)** rows 41:48.

- **Average public transport fare price per trip.** This cost data has been derived from the National Transport Model (NTM) data provided by DfT specifically for the purpose of this model. It corresponds to test year 2020 in the NTM. Price base for the fares is unknown so assumed to be 2010, and reflected in the overall uncertainty score is cell D332. As this data has been derived for the purpose of the model specifically it is not expected to be available for future updates of the model, unless it is provided directly by the DfT.

Box 81 Average public transport fare price per trip

In Rows 321:324 average fares for buses and rail are provided for London, Inner and outer conurbations, Other urban and rural areas. In row 325 an average fare for whole Great Britain is provided. In columns E:F and G:H, low scenario and high scenario estimates are calculated using the uncertainty estimate in cell D326.

Average public transport fare price per trip

	Central		Low		High	
	Buses	Rail	Buses	Rail	Buses	Rail
London	142	221	71	111	213	332
Inner & outer conurbations	175	404	88	202	263	606
Other urban	166	437	83	219	249	656
Rural	161	688	81	344	242	1032
GB total	163	333	82	167	245	500

Unit:	p/trip		
Reference:	derived		
Data uncertainty score:	low	2	
Comments:	Uncertainty estimate	50%	

This data feeds into **Calcs-AffordIndiv(Transport)** rows 206:239.

- **Detailed household expenditure by disposable income decile group, UK, 2013.** This cost data is provided from the Office for National Statistics, Family Spending, 2014 Edition, Table 3.1. This data is expected to be published in the same format in the future years. It provides information on the average spending on personal travel by car per household in each income decile.

Box 82 Detailed household expenditure by disposable income decile group, UK, 2013

The data is located in **Inputs-AffordIndividuals** Rows 340:362.

Detailed household expenditure by disposable income decile group, UK, 2013

Decile group		Lowest	Second	Third
Commodity or service				
Transport		**16.30**	**19.10**	**33.30**
7.1	Purchase of vehicles	4.20	3.60	7.50
7.1.1	Purchase of new cars and vans	[2.20]	[1.00]	[2.70]
7.1.2	Purchase of second hand cars or vans	1.90	2.60	4.70
7.1.3	Purchase of motorcycles and other vehicles	[0.10]	-	[0.00]
7.2	Operation of personal transport	7.30	10.60	18.20
7.2.1	Spares and accessories	[0.50]	[0.40]	0.90
7.2.2	Petrol, diesel and other motor oils	5.00	7.60	13.00
7.2.3	Repairs and servicing	1.30	2.10	2.80
7.2.4	Other motoring costs	0.50	0.50	1.40

This data feeds into **Calcs-AffordIndiv(Transport)** rows 120:152.

10.3 Calculations

Calculations are undertaken in the following worksheets: **Calcs-AffordIndiv (Transport) and Calcs-AffordIndiv (Domestic).** The assessment method differs between the two worksheets and is described in this section separately.

Assessment of policies affecting transport patterns

Calculations for this impact are undertaken in **Calcs-AffordIndiv (Transport)**. Rows 3:290 contain summary of all inputs required for the assessment. The calculation is undertaken in the following steps:

- **Step 1: Calculate counterfactual travel costs per household**

This step calculates counterfactual travel expenditure on a typical household for each quintile, transport mode and the start year of the assessment (as per use input). Calculations are undertaken in **Calcs-AffordIndiv(Transport)** rows 294:393.

Box 83 Calculate counterfactual travel costs per household

Calculation uses the following fixed inputs which are multiplied by each other:

- Proportion of petrol to diesel vehicles ownership by income quintile, 2013 - **Calcs-AffordIndiv(Transport)** rows 22:37
- Average fuel consumption - **Calcs-AffordIndiv(Transport)** rows 50:62
- Average annual car mileage per year per household - **Calcs-AffordIndiv(Transport)** rows 64:79
- Average fuel prices - **Calcs-AffordIndiv(Transport)** rows 95:107
- Average weekly household expenditure by disposable income decile group, UK, 2013 – Operation of personal transport (pence) (excl. petrol, diesel and other motor oils) by quintiles – **Calcs-AffordIndiv(Transport)** rows 120:152
- Average public transport fare price per trip - **Calcs-AffordIndiv(Transport)** rows 206:239
- Number of trips per household per year, 2013 - **Calcs-AffordIndiv(Transport)** rows 154:169

In the calculation, the counterfactual travel cost from a typical household is adjusted for in each quintile, mode of transport (i.e. petrol car, diesel car, Bus and Rail) and each year of the appraisal period. This allows adjustments in the future travel costs per household for changes that are expected to happen under the business as usual scenario (without additional policy in place). The calculation is undertaken for each fuel type, each income quintile and each year of the assessment for different uncertainty scenarios separately:

- Central scenario - **Calcs-AffordIndiv(Transport)** rows 312:337
- Low scenario - **Calcs-AffordIndiv(Transport)** rows 339:364
- High scenario - **Calcs-AffordIndiv(Transport)** rows 366:391

	Central						
Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	All	138,873.31	138,050	138,319	139,466	140,674	142,303
	1st	86,082	85,376	85,607	86,591	87,627	89,025
	2nd	110,849	110,063	110,320	111,415	112,567	114,123
	3rd	141,760	140,939	141,208	142,351	143,555	145,181
	4th	154,869.59	153,996	154,282	155,498	156,778	158,506
	5th	190,764	189,939	190,209	191,357	192,567	194,200
Diesel car	All	104,932	104,358	104,479	105,161	105,878	106,872
	1st	50,477	50,059	50,147	50,644	51,167	51,892
	2nd	70,215	69,761	69,856	70,395	70,962	71,748
	3rd	95,051	94,625	94,715	95,221	95,752	96,490
	4th	119,805	119,186	119,316	120,051	120,825	121,897
	5th	176,998	176,192	176,362	177,319	178,326	179,722
Bus	All	24,812	24,812	24,812	24,812	24,812	24,812
	1st	47,511	47,511	47,511	47,511	47,511	47,511
	2nd	26,963	26,963	26,963	26,963	26,963	26,963
	3rd	22,903	22,903	22,903	22,903	22,903	22,903
	4th	14,846	14,846	14,846	14,846	14,846	14,846
	5th	11,847	11,847	11,847	11,847	11,847	11,847
Rail	All	23,638	23,638	23,638	23,638	23,638	23,638
	1st	16,868	16,868	16,868	16,868	16,868	16,868
	2nd	16,418	16,418	16,418	16,418	16,418	16,418
	3rd	17,637	17,637	17,637	17,637	17,637	17,637
	4th	22,075	22,075	22,075	22,075	22,075	22,075
	5th	45,183	45,183	45,183	45,183	45,183	45,183

Results of this calculation feeds into **Calcs-AffordIndiv(Transport)** sheets:

- Step 5 in rows 676:790,
- Step 6 in rows 793:905,
- Step 8 in rows 941:973, and
- Step 9 in rows 976:1005.

▶ Step 2: Calculate scenario travel / number of trips

This step calculates the future scenario travel per household as a result of the policy implementation, in miles for cars and in number of trips for public transport. Calculation is undertaken in **Calcs-AffordIndiv (Transport)** rows 396:514.

Box 84 Calculate scenario travel/ number of trips

Calculation uses the following fixed inputs:

- Proportion of petrol to diesel vehicles ownership by income quintile, 2013 - **Calcs-AffordIndiv(Transport)** rows 22:37
- Average annual car mileage per year per household - **Calcs-AffordIndiv(Transport)** rows 64:79

Box 84 Calculate scenario travel/ number of trips

- Increase in annual car travel per household - **Calcs-AffordIndiv(Transport)** rows 81:93

- Number of trips per household per year, 2013 - **Calcs-AffordIndiv(Transport)** rows 154:169

- Increase in public transport (trips per household) - **Calcs-AffordIndiv(Transport)** rows 171:204

In this step, the calculation of the total distance of cars travelled (i.e. petrol and diesel car) and total number of trips per public transport (i.e. bus and rail) is adjusted for each year of the appraisal period as a result of the policy implementation (provided as a user input). Calculations are undertaken for different uncertainty scenarios separately:

- Central scenario - **Calcs-AffordIndiv(Transport)** rows 414:445

- Low scenario - **Calcs-AffordIndiv(Transport)** rows 447:478

- High scenario - **Calcs-AffordIndiv(Transport)** rows 480:511

Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	All	4,650	4,650	4,650	4,650	4,650	4,650
	1st	3,990	3,990	3,990	3,990	3,990	3,990
	2nd	4,438	4,438	4,438	4,438	4,438	4,438
	3rd	4,637	4,637	4,637	4,637	4,637	4,637
	4th	4,930	4,930	4,930	4,930	4,930	4,930
	5th	4,659	4,659	4,659	4,659	4,659	4,659
Diesel car	All	3,273	3,273	3,273	3,273	3,273	3,273
	1st	2,387	2,387	2,387	2,387	2,387	2,387
	2nd	2,588	2,588	2,588	2,588	2,588	2,588
	3rd	2,428	2,428	2,428	2,428	2,428	2,428
	4th	3,530	3,530	3,530	3,530	3,530	3,530
	5th	4,595	4,595	4,595	4,595	4,595	4,595
Electric car	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Bus	All	152	152	152	152	152	152
	1st	291	291	291	291	291	291
	2nd	165	165	165	165	165	165
	3rd	141	141	141	141	141	141
	4th	91	91	91	91	91	91
	5th	73	73	73	73	73	73
Rail	All	71	71	71	71	71	71
	1st	51	51	51	51	51	51
	2nd	49	49	49	49	49	49
	3rd	53	53	53	53	53	53
	4th	66	66	66	66	66	66
	5th	136	136	136	136	136	136

This calculation feeds into **Calcs-AffordIndiv(Transport)** Step 4 in rows 555:673.

Step 3: Calculate scenario fuel prices/ trip fare

This step calculates future fuel prices for cars and future trip fares for public transport as a result of implementing the policy or measure. Calculations are made in **Calcs-AffordIndiv (Transport)** rows 517:552.

Box 85 Calculate scenario fuel prices/ trip fare

Calculation uses the following inputs which are multiplied by each other:

- Average fuel prices - **Calcs-AffordIndiv(Transport)** rows 95:107
- Increase in road fuel prices due to the policy/measure (pence per litre) - **Calcs-AffordIndiv(Transport)** rows 109:118
- Average public transport fare price per trip - **Calcs-AffordIndiv(Transport)** rows 206:239
- Increase in average fares per trip due to the application of the policy/measures - **Calcs-AffordIndiv(Transport)** rows 241:274

The future fuel price for cars and trip fares for public transports as a result of the policy or measure is adjusted in this calculation. The average fuel prices is compared with the increased cost of the road to give fuel price for cars. Average public transport fares is compared with the increase in average fares per trip after the new policy/measure is applied. Calculations are undertaken for each transport type under each uncertainty scenario.

Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	Central	127	126	126	128	130	132
	Low	124	124	125	125	126	127
	High	140	142	144	147	150	152
Diesel car	Central	134	133	133	135	137	139
	Low	130	130	131	132	132	133
	High	149	151	153	156	159	162
Electric car	Central	16	17	18	18	19	19
	Low	15	16	16	17	18	18
	High	17	18	20	20	21	22
Bus	Central	163	163	163	163	163	163
	Low	82	82	82	82	82	82
	High	245	245	245	245	245	245
Rail	Central	333	333	333	333	333	333
	Low	167	167	167	167	167	167
	High	500	500	500	500	500	500

This calculation feeds into **Calcs-AffordIndiv(Transport)** Step 4 in rows 555:673.

Step 4: Calculate scenario travel costs

This step calculates the future scenario travel costs for a typical household and for each transport mode. It takes into account changes in mileage/ number of trips, fuel and fares prices and vehicle maintenance. Calculations are made in **AffordIndiv(Transport)** rows 555:673.

Box 86 Calculate scenario travel costs

Calculation uses the following inputs:

- Average weekly household expenditure by disposable income decile group, UK, 2013 – Operation of personal transport (pence) (excl. petrol, diesel and other motor oils) by quintiles – **Calcs-AffordIndiv(Transport)** rows 120:152
- Average fuel consumption - **Calcs-AffordIndiv(Transport)** rows 50:62
- Scenario travel/number of trips – calculated in step 2 - **Calcs-AffordIndiv(Transport)** rows 396:514
- Scenario fuel prices/trip fare – calculated in step 3 - **Calcs-AffordIndiv(Transport)** rows 517:552

The calculation in this step provides the future scenario travel costs for a typical household by each mode of transport (i.e. petrol car, diesel car, electric car, bus and rail). The average fuel consumption, number of trips and trip fare are multiplied and adjusted with the average weekly household expenditure by disposable income for each year of the appraisal period. It takes into account changes in mileage or number of trips, fuel and fare prices and vehicle maintenance. Calculations are undertaken for different uncertainty scenarios separately:

- Central scenario - **Calcs-AffordIndiv(Transport)** rows 573:604
- Low scenario - **Calcs-AffordIndiv(Transport)** rows 606:637
- High scenario - **Calcs-AffordIndiv(Transport)** rows 639:670

Box 86 Calculate scenario travel costs

	Central						
Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	All	138,873	138,050	138,319	139,466	140,674	142,303
	1st	86,082	85,376	85,607	86,591	87,627	89,025
	2nd	110,849	110,063	110,320	111,415	112,567	114,123
	3rd	141,760	140,939	141,208	142,351	143,555	145,181
	4th	154,870	153,996	154,282	155,498	156,778	158,506
	5th	190,764	189,939	190,209	191,357	192,567	194,200
Diesel car	All	104,932	104,358	104,479	105,161	105,878	106,872
	1st	50,477	50,059	50,147	50,644	51,167	51,892
	2nd	70,215	69,761	69,856	70,395	70,962	71,748
	3rd	95,051	94,625	94,715	95,221	95,752	96,490
	4th	119,805	119,186	119,316	120,051	120,825	121,897
	5th	176,998	176,192	176,362	177,319	178,326	179,722
Electric car	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Bus	All	24,812	24,812	24,812	24,812	24,812	24,812
	1st	47,511	47,511	47,511	47,511	47,511	47,511
	2nd	26,963	26,963	26,963	26,963	26,963	26,963
	3rd	22,903	22,903	22,903	22,903	22,903	22,903
	4th	14,846	14,846	14,846	14,846	14,846	14,846
	5th	11,847	11,847	11,847	11,847	11,847	11,847
Rail	All	23,638	23,638	23,638	23,638	23,638	23,638
	1st	16,868	16,868	16,868	16,868	16,868	16,868
	2nd	16,418	16,418	16,418	16,418	16,418	16,418
	3rd	17,637	17,637	17,637	17,637	17,637	17,637
	4th	22,075	22,075	22,075	22,075	22,075	22,075
	5th	45,183	45,183	45,183	45,183	45,183	45,183

This calculation feeds into **Calcs-AffordIndiv(Transport)** Step 5 in rows 676:790.

Step 5: Calculate expenditure change

In this step, the new household expenditure on travel (i.e. after the policy under assessment is implemented) is compared to the old household expenditure on travel (i.e. before the policy under assessment is implemented). Calculations are made in **Calcs-AffordIndiv(Transport)** rows 676:790.

Box 87 Calculate expenditure change

Calculation uses the following inputs:

- Counterfactual travel costs per household – calculated in step 1 - **Calcs-AffordIndiv(Transport)** rows 294:393
- Scenario travel costs – calculated in step 4 - **Calcs-AffordIndiv(Transport)** rows 555:673.

The counterfactual travel costs are subtracted from the scenario travel costs so that only the change as a result of the policy is determined. The calculation is repeated for transport mode (i.e. petrol car, diesel car, electric car, bus and rail) and each uncertainty scenario separately:

- Central scenario - **Calcs-AffordIndiv(Transport)** rows 690:721
- Low scenario - **Calcs-AffordIndiv(Transport)** rows 723:754
- High scenario - **Calcs-AffordIndiv(Transport)** rows 756:787

	Central						
Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Diesel car	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Electric car	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Bus	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Rail	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-

This calculation feeds into **Calcs-AffordIndiv(Transport)** step 6 in rows 793:905 and step 7 in rows 908:938.

- Step 6: Calculate percentage expenditure change on counterfactual

This step calculates the percentage change in expenditure, relative to the counterfactual expenditure per mode of transport and quintile. Calculations are made in **AffordIndiv (Transport)** rows 793:905.

Box 88 **Calculate percentage expenditure change on counterfactual**

Calculation uses the following inputs:

- Counterfactual travel costs per household – calculated in step 1 - **Calcs-AffordIndiv(Transport)** rows 294:393

- Expenditure change – calculated in step 5 - **Calcs-AffordIndiv(Transport)** rows 676:790

The annual expenditure change per household are divided by the Counterfactual travel costs. The calculation is repeated for each transport mode and uncertainty scenario to provide the percentage expenditure change on counterfactual.

- Central scenario - **Calcs-AffordIndiv(Transport)** rows 806:837

- Low scenario - **Calcs-AffordIndiv(Transport)** rows 839:870

- High scenario - **Calcs-AffordIndiv(Transport)** rows 827:903

	Central						
Mode	Quintile	2015	2016	2017	2018	2019	2020
Petrol car	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%
Diesel car	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%
Electric car	All						
	1st						
	2nd						
	3rd						
	4th						
	5th						
Bus	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%
Rail	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%

- Step 7: Total expenditure change per average household by quantile

In this step, total change in energy expenditure is summed for an average household per quantile. Calculations are made in **Calcs-AffordIndiv(Transport)** rows 908:938.

Box 89 **Calculate the total expenditure change per average household by quantile**

Calculation uses the following inputs:

- Expenditure change – calculated in step 5 - **Calcs-AffordIndiv(Transport)** rows 676:790

All transport mode is summed to calculate the total expenditure change after implementation of the policy for each average household per quantile. The calculation is repeated for each uncertainty scenario.

Box 89 Calculate the total expenditure change per average household by quantile

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
Low	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-
High	All	-	-	-	-	-	-
	1st	-	-	-	-	-	-
	2nd	-	-	-	-	-	-
	3rd	-	-	-	-	-	-
	4th	-	-	-	-	-	-
	5th	-	-	-	-	-	-

This calculation feeds into **Calcs-AffordIndiv(Transport)** step 8 in rows 941:973.

Step 8: Calculate the percentage change on expenditure to counterfactual by quintile

In this step, the percentage change in expenditure relative to the counterfactual by income quintile is calculated. This is applied to the sum of household expenditure for each year. Calculations are made in **Calcs-AffordIndiv (Transport)** rows 941:973.

Box 90 Calculate the percentage change on expenditure to counterfactual by quintile

Calculation uses the following inputs:

- Counterfactual travel costs per household – calculated in step 1 - Calcs-AffordIndiv(Transport) rows 294:393
- Total expenditure change per average household by quantile – calculated in step 7 - Calcs-AffordIndiv(Transport) rows 908:938

The total expenditure change per average household by quantile is divided by the sum of all counterfactual costs of transport mode per household quintile. The calculation is repeated for each uncertainty scenario. Results are expressed as a percentage.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%
Low	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%
High	All	0%	0%	0%	0%	0%	0%
	1st	0%	0%	0%	0%	0%	0%
	2nd	0%	0%	0%	0%	0%	0%
	3rd	0%	0%	0%	0%	0%	0%
	4th	0%	0%	0%	0%	0%	0%
	5th	0%	0%	0%	0%	0%	0%

This table is not carried forward to the results tab but provides useful information to the model user (i.e. see which income quintiles will incur in a cost over 10% against the counterfactual, as recommended by WebTAG).

Step 9: Calculate the percentage change on expenditure to income

In this step, the counterfactual travel costs per household are compared to the average annual income per household in each income quintile. Calculations are made in **Calcs-AffordIndiv(Transport)** rows 976:1005.

Box 91 Calculate the percentage change on expenditure to income

Calculation uses the following inputs:

- Counterfactual travel costs per household – calculated in step 1 - **Calcs-AffordIndiv(Transport)** rows 294:393

- Annual household disposable income per quintile – fixed input shown in **Calcs-AffordIndiv(Transport)** rows 276:285

In the calculation, the counterfactual travel costs per household are divided by the average annual household's disposal income. The calculation is repeated for each uncertainty scenario. Results are expressed as a percentage of disposable income that counterfactual travel would cost per household.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Low	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
High	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

This calculation provides one of the outputs for this assessment and feeds into the annual costs and benefit **Results**-**AffordIndiv** sheet for percentage of change in annual travel expenditure over disposable income in rows 48:80

- Step 10: Calculate the affordability of capital expenditure

This step calculates the capital costs expected to be incurred by a household to achieve compliance with the policy and the affordability for each income quintile. Although not restricted to it, this step was developed to assess the affordability of car scrappage schemes and similar policies. Calculations are made in **Calcs-AffordIndiv (Transport)** rows 1008:1089.

Box 92 Calculate the affordability of capital expenditure

Calculation uses the following inputs:

- Age of cars affected by policy – fixed input shown in in **Calcs-AffordIndiv(Transport)** rows 16:18

- Capital cost per household in policy implementation year – fixed input shown in **Calcs-AffordIndiv(Transport)** rows 39:48

- Proportion of vehicles by vehicle age and household income quintile; England, 2013 – fixed input shown in **Calcs-AffordIndiv(Transport)** rows 5:14

- Proportion of petrol to diesel vehicles ownership by income quintile, 2013 – fixed input shown in **Calcs-AffordIndiv(Transport)** rows 22:37

- Average car liftime in the absence of measure/policy – **Calcs-AffordIndiv(Transport)** Cell D20

- Annual household disposable income per quintile – fixed input shown in **Calcs-AffordIndiv(Transport)** rows 276:285

The principle behind this assessment is the fact that if households buy a car before the lifespan of their old car has expired, in the long run they will buy a higher number of cars. If we divide the cost of a car by its lifetime, we get the cost per car-year. For example, if a household spend £13,000 in a car meant to last 13 years, the cost of a car-year will be £1,000. Therefore, if they buy a new car before the lifespan of the car has been reached they will be losing a number of car-years. Following the same example, if a household discard their car after 9 years, the cost of early buying will be (13-9 years = 4 years x £1,000 per car-year = £4,000). This capital cost of early buying is assumed to be paid in the first year of the policy implementation.

The input for the average car lifetime in the absence of measure/policy was set by the user in the Control-AffordIndiv sheet, cell C66. An example of the calculation table of additional cost of early buying of cars can be found below.

Additional cost of early buying a new car (£)	Age of the car:	0	2	4	6	8	10	13
Petrol	Central	0	0	0	0	3846	2308	0
	Low	0	0	0	0	3077	1846	0
	High	0	0	0	0	5000	3000	0
Diesel	Central	0	0	0	0	4615	2769	0
	Low	0	0	0	0	3462	2077	0
	High	0	0	0	0	7692	4615	0

Additional cost of early purchase in an average household per quantile and car type (£) compares the proportion of vehicles by age and ownership with the age of the cars as calculated in the previous calculation above. This was conducted for all uncertainty scenarios.

Box 92 Calculate the affordability of capital expenditure

Central scenario

Additional cost of early purchase in an average household per quantile and car type (£)		Up to 2 years	Over 2 to 4 y	Over 4 to 6 y	Over 6 to 8 y	Over 8 to 10	Over 10 to 13	Over 13 years
Petrol	All	0	0	0	0	611	410	0
	1st	0	0	0	0	651	490	0
	2nd	0	0	0	0	657	472	0
	3rd	0	0	0	0	662	469	0
	4th	0	0	0	0	605	407	0
	5th	0	0	0	0	528	288	0
Diesel	All	0	0	0	0	733	492	0
	1st	0	0	0	0	782	588	0
	2nd	0	0	0	0	788	567	0
	3rd	0	0	0	0	795	563	0
	4th	0	0	0	0	726	488	0
	5th	0	0	0	0	634	346	0

The information calculated in previous tables are then combined into this table as shown below. The data for petrol or diesel are aggregate and then the information is compared with each income quantile

Additional cost of early purchase in an average household per quantile (£)

2020	Average annual expenditure on vehicles	Ownership ratio		Average additional cost per income category, weighted by car type being replaced		
Income level		Petrol car	Diesel car	Central	Low	High
All income levels	1,097	69%	31%	1,083	848	1,545
Lowest real income level	203	71%	29%	1,207	946	1,714
Second level	450	73%	27%	1,191	934	1,683
Third level	1,089	74%	26%	1,191	935	1,680
Fourth level	1,394	68%	32%	1,075	841	1,538
Highest real income level	2,353	64%	36%	876	683	1,268

Weighted cost as percentage of annual household disposable income			Average additional cost per income category in NPV		
Central	Low	High	Central	Low	High
3%	3%	5%	912	714	1,301
12%	9%	17%	1,017	797	1,443
6%	5%	9%	1,003	786	1,417
4%	3%	6%	1,003	787	1,415
3%	2%	4%	905	708	1,295
1%	1%	2%	737	575	1,068

This calculation provides one of the outputs for this assessment and feeds into the annual costs and benefit **Results**-**AffordIndiv** sheet.

Assessment of policies affecting domestic fuel use

Calculations for this impact are undertaken in **Calcs-AffordIndiv (Domestic)**. Rows 3:106 contain summary of all inputs (both user and fixed) required for the assessment. The calculation is undertaken in the following steps:

- **Step 1: Calculate counterfactual energy costs**

In order to understand the cost to each household quintile of a policy's implementation, the quintile's mean fuel expenditure is required, if the policy were not implemented. These are the 'counterfactual energy costs'. Calculations are undertaken in **Calcs-AffordIndiv (Domestic)** rows 110:148.

Box 93 Calculate counterfactual energy costs

Calculation uses the following inputs which are multiplied by each other:

- Household annual average consumption of electricity, gas and other fuels per income quintiles – **Calcs-AffordIndiv(Domestic)** rows 41:48.
- Retail energy price projections for the residential sector – **Calcs-AffordIndiv(Domestic)** rows 50:57
- Projected change in energy demand compared to 2013 – **Calcs-AffordIndiv(Domestic)** rows 59:67
- Percentage of household energy used for the purpose specified by the user in I**nputs-AffordIndiv** (row 284) and aggregated and summarised in **Calcs-AffordIndiv(Domestic)** rows 71:75.

In the calculation, the annual household energy consumption is adjusted for each year of the appraisal period by change in future energy demand. This allows adjusting the future energy costs per household for changes that are expected to happen under the business as usual (without additional policy in place).

The calculation is undertaken for each fuel type, each income quintile and each year of the assessment.

Fuel	Quintile	2015	2016	2017	2018	2019	2020	2021	2022
Electricty	1st	169.3	177.1	185.8	185.9	197.4	196.4	206.3	213.0
	2nd	186.1	194.6	204.2	204.3	217.0	215.8	226.7	234.1
	3rd	198.7	207.7	218.0	218.1	231.6	230.4	242.0	249.9
	4th	212.1	221.8	232.7	232.8	247.3	246.0	258.3	266.8
	5th	247.3	258.6	271.3	271.4	288.3	286.8	301.2	311.1
Gas	1st	391.3	395.8	409.9	409.3	405.7	395.9	413.5	417.5
	2nd	468.7	474.1	491.0	490.4	486.0	474.2	495.4	500.1
	3rd	495.2	500.9	518.8	518.1	513.4	501.0	523.4	528.4
	4th	542.1	548.3	567.9	567.1	562.0	548.4	572.9	578.4
	5th	637.8	645.2	668.2	667.3	661.3	645.3	674.1	680.6
Coal	1st	21.1	18.4	16.6	15.0	13.5	11.9	10.8	9.5
	2nd	13.8	12.1	10.9	9.8	8.9	7.8	7.1	6.2
	3rd	21.7	18.9	17.2	15.4	14.0	12.3	11.1	9.8
	4th	26.3	23.0	20.8	18.7	16.9	14.9	13.5	11.9
	5th	51.4	44.8	40.6	36.5	33.0	29.1	26.4	23.2
Oil	1st	12.4	11.5	11.7	11.6	11.7	11.6	12.2	12.1
	2nd	8.2	7.5	7.6	7.6	7.7	7.6	8.0	7.9
	3rd	12.8	11.9	12.0	12.0	12.1	12.0	12.5	12.4
	4th	15.6	14.4	14.6	14.5	14.7	14.6	15.2	15.1
	5th	30.3	28.0	28.4	28.3	28.6	28.4	29.7	29.4

Results of this calculation feed into **Calcs-AffordIndiv(Domestic**) step 5 in rows 352:433, Step 6 in rows 436:469, Step 7 in rows 472:499, Step 8 in rows 502:531 and Step 9 in rows 534:563.

▶ Step 2: Calculate scenario energy consumption per household

In this step, the new energy consumption per household (i.e. after the policy under assessment is implemented) is calculated. Calculation is undertaken in **Calcs-AffordIndiv (Domestic)** rows 150:233.

Box 94 Calculate scenario energy consumption per household

Calculation uses the following inputs which are multiplied by each other:

- Change in energy consumption per household for each fuel type - **Calcs-AffordIndiv(Domestic)** rows 9:23

- Household annual average consumption of electricity, gas and other fuels per income quintiles – **Calcs-AffordIndiv(Domestic)**rows 41:48.

- Projected change in energy demand compared to 2013 – **Calcs-AffordIndiv(Domestic)** rows 59:67.

- Percentage of household energy used for the purpose specified by the user in I**nputs-AffordIndiv** (row 284) and aggregated and summarised in **Calcs-AffordIndiv(Domestic)** rows 71:75.

In the calculation, the annual household energy consumption is adjusted for each year of the appraisal period by the expected change in energy consumption as a result of the policy (provided as a user input). Calculations are undertaken for different uncertainty scenarios separately:

- Central scenario - **Calcs-AffordIndiv(Domestic)** rows 164:185

- Low scenario - **Calcs-AffordIndiv(Domestic)** rows 187:208

- High scenario - **Calcs-AffordIndiv(Domestic)** rows 210:231

The formula follows the following pattern: If the unit of measure is kWh, sum the change in energy consumption per household for each fuel (user input) plus the household annual average consumption for each fuel (baseline energy consumption – fixed input). If the unit is %, multiply the % increase in consumption by the baseline energy consumption. In either case, this step of the equation provides us with the energy consumed by fuel per household after applying user inputs. Then this is multiplied by the percentage of energy affected by the policy (e.g. if the policy only affects energy used in heating) as specified by the user in I**nputs-AffordIndiv** (row 284) and aggregated and summarised in **Calcs-AffordIndiv(Domestic)** rows 71:75. Finally this is multiplied by the projected change in energy demand compared to 2013.

Fuel	Quintile	2015	2016	2017	2018	2019	2020
Electricity	1st	501.9	524.8	550.6	550.9	585.1	582.1
	2nd	551.6	576.8	605.1	605.4	643.1	639.7
	3rd	588.8	615.7	646.0	646.3	686.5	683.0
	4th	628.6	657.3	689.6	689.9	732.9	729.1
	5th	732.9	766.4	804.1	804.5	854.5	850.1
Gas	1st	442.0	447.1	463.0	462.4	458.2	447.2
	2nd	529.4	535.6	554.7	553.9	548.9	535.7
	3rd	559.4	565.8	586.0	585.2	580.0	565.9
	4th	612.3	619.4	641.5	640.6	634.9	619.5
	5th	720.5	728.8	754.8	753.8	747.0	729.0
Coal	1st	49.6	43.3	39.2	35.2	31.9	28.1
	2nd	32.5	28.4	25.7	23.1	20.9	18.4
	3rd	51.1	44.6	40.4	36.3	32.8	28.9
	4th	62.0	54.1	49.0	44.0	39.8	35.1
	5th	120.9	105.4	95.5	85.9	77.6	68.4
Oil	1st	13.1	12.1	12.2	12.2	12.3	12.2
	2nd	8.6	7.9	8.0	8.0	8.1	8.0
	3rd	13.5	12.4	12.6	12.6	12.7	12.6
	4th	16.3	15.1	15.3	15.2	15.4	15.3
	5th	31.8	29.4	29.8	29.7	30.0	29.8

This calculation feeds into **Calcs-AffordIndiv(Domestic)** Step 4 rows 268:349.

Step 3: Calculate scenario energy prices

In this step, the new energy prices (i.e. after the policy under assessment is implemented) are calculated. Calculations are made in **AffordIndiv (Domestic)** rows 237:264.

Box 95 Calculate scenario energy prices

Calculation uses the following inputs which are multiplied by each other:

- Change in domestic fuel prices due to the application of the policy/measure - **Calcs-AffordIndiv(Domestic)** rows 9:23 (i.e. user input)

- Retail energy projections - **Calcs-AffordIndiv(Domestic)** rows 50:57

In the calculation, the household energy prices per unit of energy are adjusted by the expected changes in energy prices as a result of the policy. Calculations are undertaken for each fuel type (electricity, gas, coal, oil) under each uncertainty scenario.

		2015	2016	2017	2018	2019	2020	2021
Electricity	Central	0.08	0.08	0.09	0.09	0.10	0.10	0.10
	Low	0.03	0.03	0.04	0.04	0.04	0.04	0.04
	High	0.11	0.12	0.13	0.13	0.13	0.13	0.14
Gas	Central	0.02	0.03	0.03	0.03	0.03	0.02	0.03
	Low	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	High	0.03	0.04	0.04	0.04	0.04	0.03	0.04
Coal	Central	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Low	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	High	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Oil	Central	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Low	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	High	0.04	0.04	0.04	0.04	0.04	0.04	0.04

This calculation feeds into **Calcs-AffordIndiv(Domestic)** Step 4 rows 268:349.

Step 4: Calculate scenario energy costs

In this step, the new household expenditure on energy (i.e. after the policy under assessment is implemented) is calculated. Calculations are made in **AffordIndiv(Domestic)** rows 268:349.

Box 96 Calculate scenario energy costs

Calculation uses the following inputs which are multiplied by each other:

- Scenario energy consumption – calculated in step 2 - **Calcs-AffordIndiv(Domestic)** rows 150:233.

- Scenario energy prices - calculated in step 3 - **Calcs-AffordIndiv(Domestic)** rows 237:264.

The calculation is repeated for each fuel type and each uncertainty scenario.

Central Scenario

Fuel	Quintile	2015	2016	2017	2018	2019	2020
Electricity	1st	45.2	48.2	51.2	51.6	55.0	55.0
	2nd	49.7	53.0	56.3	56.8	60.4	60.4
	3rd	53.1	56.6	60.1	60.6	64.5	64.5
	4th	56.6	60.4	64.2	64.7	68.9	68.8
	5th	66.0	70.4	74.8	75.4	80.3	80.2
Gas	1st	104.2	111.7	116.1	114.0	111.3	111.0
	2nd	124.9	133.8	139.0	136.6	133.3	133.0
	3rd	131.9	141.4	146.9	144.3	140.8	140.5
	4th	144.4	154.8	160.8	157.9	154.2	153.8
	5th	169.9	182.1	189.2	185.8	181.4	181.0
Coal	1st	6.9	7.0	7.0	7.1	7.1	7.1
	2nd	4.5	4.6	4.6	4.6	4.7	4.7
	3rd	7.1	7.2	7.3	7.3	7.3	7.4
	4th	8.7	8.7	8.8	8.9	8.9	8.9
	5th	16.9	17.0	17.2	17.3	17.3	17.4
Oil	1st	3.0	2.9	2.9	2.9	2.9	3.0
	2nd	2.0	1.9	1.9	1.9	1.9	2.0
	3rd	3.1	3.0	3.0	3.0	3.0	3.1
	4th	3.7	3.6	3.6	3.6	3.7	3.7
	5th	7.3	7.1	7.0	7.1	7.1	7.3

This calculation feeds into **Calcs-AffordIndiv(Domestic)** Step 5 rows 352:433.

Step 5: Calculate expenditure change

In this step, the new household expenditure on energy (i.e. after the policy under assessment is implemented) is compared to the old household expenditure on energy (i.e. before the policy under assessment is implemented). Calculations are made in **AffordIndiv(Domestic)** rows 352:433.

Box 97 Calculate expenditure change

Calculation uses the following inputs:

- Counterfactual energy costs– calculated in step 1 - **Calcs-AffordIndiv(Domestic)** rows 110:148.

- Scenario energy costs - calculated in step 4 - **Calcs-AffordIndiv(Domestic)** rows 268:349.

The counterfactual energy costs are subtracted from the scenario energy costs so that only a change as a result of the policy is determined. The calculation is repeated for each fuel type and each uncertainty scenario.

Central Scenario

Fuel	Quintile	2015	2016	2017	2018	2019	2020
Electricity	1st	-124.1	-128.9	-134.5	-134.2	-142.5	-141.5
	2nd	-136.4	-141.6	-147.8	-147.5	-156.6	-155.5
	3rd	-145.6	-151.2	-157.8	-157.5	-167.1	-166.0
	4th	-155.5	-161.4	-168.5	-168.1	-178.4	-177.2
	5th	-181.3	-188.2	-196.5	-196.0	-208.0	-206.6
Gas	1st	-287.0	-284.1	-293.8	-295.4	-294.4	-284.8
	2nd	-343.8	-340.3	-352.0	-353.8	-352.6	-341.2
	3rd	-363.3	-359.5	-371.9	-373.8	-372.6	-360.5
	4th	-397.6	-393.6	-407.1	-409.2	-407.8	-394.6
	5th	-467.9	-463.1	-479.0	-481.5	-479.9	-464.3
Coal	1st	-14.1	-11.4	-9.6	-7.9	-6.4	-4.8
	2nd	-9.3	-7.5	-6.3	-5.2	-4.2	-3.1
	3rd	-14.6	-11.7	-9.9	-8.1	-6.6	-4.9
	4th	-17.7	-14.2	-12.0	-9.9	-8.0	-6.0
	5th	-34.5	-27.8	-23.4	-19.2	-15.6	-11.7
Oil	1st	-9.4	-8.6	-8.8	-8.7	-8.8	-8.7
	2nd	-6.2	-5.6	-5.8	-5.7	-5.8	-5.7
	3rd	-9.7	-8.9	-9.1	-9.0	-9.1	-8.9
	4th	-11.8	-10.8	-11.0	-10.9	-11.0	-10.8
	5th	-23.0	-21.0	-21.4	-21.3	-21.5	-21.1

This calculation feeds into **Calcs-AffordIndiv(Domestic)** Step 6 rows 436:469

▶ Step 6: Calculate percentage expenditure change on counterfactual

In this step, the change in energy expenditure per household (as calculated in step 5 above) is compared to the old household expenditure on energy (i.e. before the policy under assessment is implemented). Calculations are made in **AffordIndiv(Domestic)** rows 436:469.

Box 98 Calculate percentage expenditure change on conterfactual

Calculation uses the following inputs:

- Counterfactual energy costs– calculated in step 1 - **Calcs-AffordIndiv(Domestic)** rows 110:148.

- Change in energy costs per household - calculated in step 5 - **Calcs-AffordIndiv(Domestic)** rows 352:433.

The changes in energy costs per household are divided by the Counterfactual energy costs. The calculation is repeated for each fuel type and each uncertainty scenario. The percentage change is the same across the income quintiles.

Central Scenario

Fuel	2015	2016	2017	2018	2019	2020
Electricity	140%	148%	138%	125%	125%	125%
Gas	125%	140%	155%	125%	125%	125%
Coal	125%	140%	155%	125%	125%	125%
Oil	125%	140%	155%	125%	125%	125%

▶ Step 7: Total expenditure change per average household by quantile

In this step, the change in energy expenditure per household is summed and compared to the counterfactual expenditure cost to each household quintile to provide the total change in energy expenditure after the policy under assessment is implemented. Calculations are made in **AffordIndiv(Domestic)** rows 472:499.

Box 99 Calculate the total expenditure change on average household by quantile

Calculation uses the following inputs:

- Counterfactual energy costs– calculated in step 1 - **Calcs-AffordIndiv(Domestic)** rows 110:148.

- Change in energy costs per household - calculated in step 5 - **Calcs-AffordIndiv(Domestic)** rows 352:433.

The change in energy costs per household are summed with the counterfactual energy costs per average annual household. The calculation is repeated for each uncertainty scenario.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	1,333.4	1,480.0	1,557.1	1,325.9	1,359.4	1,336.9
	2nd	1,485.4	1,654.2	1,747.0	1,488.1	1,526.2	1,502.3
	3rd	1,604.3	1,783.3	1,881.9	1,600.6	1,640.0	1,613.1
	4th	1,743.3	1,936.7	2,045.5	1,737.3	1,778.7	1,748.7
	5th	2,117.6	2,343.4	2,473.7	2,092.4	2,136.5	2,096.6

This calculation provides one of the outputs for this assessment and feeds into **Calcs-AffordIndiv(Domestic)** sheet step 8 in rows 502:531 and Step 9 in rows 534:563 and into the discounted calculation conducted in **Calcs-AffordIndiv(Domestic)** rows 649:664**.**

▶ Step 8: Calculate the percentage change on expenditure to counterfactual by quintile

In this step, the total expenditure change (as calculated in step 7 above) in energy is compared to the counterfactual expenditure cost to each household quintile of a policy's implementation. Calculations are made in **AffordIndiv(Domestic)** rows 502:531.

Box 100 Calculate the percentage change on expenditure to counterfactual

Calculation uses the following inputs:

- Counterfactual energy costs– calculated in step 1 - **Calcs-AffordIndiv(Domestic)** rows 110:148.

- Total expenditure change – calculated in step 7 - **Calcs-AffordIndiv(Domestic)** rows 472:499.

The total expenditure change in energy costs per household are divided by the counterfactual energy costs per household quintile. The calculation is repeated for each uncertainty scenario.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	132.5%	144.1%	146.2%	125.0%	125.0%	125.0%
	2nd	132.4%	144.0%	146.4%	125.0%	125.0%	125.0%
	3rd	132.3%	144.0%	146.5%	125.0%	125.0%	125.0%
	4th	132.1%	143.9%	146.6%	125.0%	125.0%	125.0%
	5th	131.8%	143.8%	146.9%	125.0%	125.0%	125.0%

▶ Step 9: Calculate the percentage change on expenditure to income

Step 9 compares the total expenditure change (as calculated in step 7) to the counterfacutal expenditure cost to each household over annual disposable income per quintile of a policy's implementation. Calculations are made in **AffordIndiv(Domestic)** rows 534:563.

Box 101 Calculate the percentage change on expenditure to income

Calculation uses the following inputs:

- Counterfactual energy costs– calculated in step 1 - **Calcs-AffordIndiv(Domestic)** rows 110:148.

- Total expenditure change – calculated in step 7 - **Calcs-AffordIndiv(Domestic)** rows 472:499.

- Annual household disposable income per quintile - fixed input shown in **Calcs-AffordIndiv(Domestic)** rows 83:91.

The total expenditure and energy costs per household are divided by the average annual household's disposal income. The calculation is repeated for each uncertainty scenario.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	13.1%	14.6%	15.4%	13.1%	13.4%	13.2%
	2nd	7.6%	8.5%	8.9%	7.6%	7.8%	7.7%
	3rd	5.8%	6.5%	6.9%	5.8%	6.0%	5.9%
	4th	4.6%	5.2%	5.5%	4.6%	4.7%	4.7%
	5th	3.3%	3.6%	3.8%	3.2%	3.3%	3.2%
Low	1st	4.4%	4.5%	5.9%	4.6%	4.7%	4.6%
	2nd	2.5%	2.6%	3.4%	2.7%	2.7%	2.7%
	3rd	1.9%	2.0%	2.6%	2.1%	2.1%	2.1%
	4th	1.5%	1.6%	2.1%	1.6%	1.7%	1.6%
	5th	1.1%	1.1%	1.4%	1.1%	1.2%	1.1%
High	1st	22.0%	23.4%	29.6%	19.8%	20.3%	19.9%
	2nd	12.9%	13.7%	17.0%	11.5%	11.8%	11.6%
	3rd	9.9%	10.5%	13.1%	8.8%	9.0%	8.9%
	4th	7.9%	8.4%	10.5%	7.0%	7.2%	7.1%
	5th	5.5%	5.8%	7.4%	4.9%	5.0%	4.9%

This calculation provides one of the outputs for this assessment and feeds into the annual costs and benefits of the **Results**-**AffordIndiv** sheet for percentage of change in domestic energy expenditure over disposable income (transitional and annual) in rows 160:222.

Step 10: Distribute capital transitional cost across the years

Step 10 here calculates the distributed capital transitional cost of each household to achieve compliance with the policy implemented across the relevant number of years. Calculations are made in **AffordIndiv(Domestic)** rows 566:595.

Box 102 Calculate the distribute capital transitional cost across the years

Calculation uses the following inputs:

- Years over which capital cost is annualised - fixed input shown in **Calcs-AffordIndiv(Domestic)** rows 84:90

- Capital cost per household (assumed in the first year of policy/measure) (£) - fixed input shown in **Calcs-AffordIndiv(Domestic)** rows 78:82.

The capital cost (expenditure) per household are assumed to be paid over number of years after the policy implementation. The distributed capital costs is calculated by dividing the capital costs per household over which the number of years the capital cost is annualised. Under the uncertainty scenarios, number of years assumed may vary. This is reflected in the calculation for each scenario.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	-	-	-	-	-	667
	2nd	-	-	-	-	-	667
	3rd	-	-	-	-	-	667
	4th	-	-	-	-	-	667
	5th	-	-	-	-	-	667
Low	1st	-	-	-	-	-	1,500
	2nd	-	-	-	-	-	1,500
	3rd	-	-	-	-	-	1,500
	4th	-	-	-	-	-	1,500
	5th	-	-	-	-	-	1,500
High	1st	-	-	-	-	-	600
	2nd	-	-	-	-	-	600
	3rd	-	-	-	-	-	600
	4th	-	-	-	-	-	600
	5th	-	-	-	-	-	600

This calculation provides one of the outputs for this assessment and feeds into Step 11 in rows 598:627 and discounted calculation conducted in the sheet **Calcs-AffordIndiv(Domestic)** rows 669:384**.**

- **Step 11: Calculate the affordability of capital expenditure**

In this step, the table calculates the yearly percentage capital expenditure per household by average disposable income following policy implementation. Calculations are made in **AffordIndiv(Domestic)** rows 598:627.

Box 103 Calculate the affordability of capital expenditure

Calculation uses the following inputs:

- Distribute capital transitional cost across the years – calculated in step 10 - **Calcs-AffordIndiv(Domestic)** rows 566:595.

- Annual household disposable income per quintile – fixed input shown in **Calcs-AffordIndiv(Domestic)** rows 92:100.

The affordability of capital expenditure is conducted by comparing the distributed capital transitional cost paid by households across relevant years in order to achieve compliance with the policy with the annual household disposable income per quintile. The average disposal income per household in each income quintile is divided by the distributed capital transitional cost across the years for each uncertainty scenario. Results are expressed as a percentage.

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Low	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
High	1st	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2nd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3rd	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	4th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	5th	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

This calculation provides one of the outputs for this assessment and feeds into the capital transitional costs and benefits of the **Results-AffordIndiv** sheet for percentage of change in domestic energy expenditure over disposable income (transitional and annual) in rows 160:222

10.4 Results-affordindiv and results-summary

Changes associated with “transport” and “domestic” expenditure are calculated in sheets (**Calcs-AffordIndiv (Transport)** and **Calcs-AffordIndiv (Domestic)** over a selected number of years from the start of the policy/measure implementation. Calculations for discounted change in expenditure are undertaken within the outputs tables, **Calcs-AffordIndiv (Transport)** rows 1092:1141 and **Calcs-AffordIndiv (Domestic)** rows 630:686 for “transport” and “domestic” respectively.

Box 104 Discount change to “transport” and “domestic” expenditure over the appraisal period

The final outputs presented in the **Calcs-AffordIndiv(Transport)** and **Calcs-AffordIndiv(Domestic)** sheets provides the data on the change of ‘transport” and “domestic” expenditure after the implementation of the policy/measure over the appraisal period. The calculated discounted costs for the change in “transport” and “domestic” expenditure uses the relevant discount rate from the control panel.

Uncertainty is carried through the calculations. This is done using two parallel systems:

- Calculations are done for the three uncertainty scenarios (low, medium and high) as provided by the user.
- A qualitative scoring system considers the uncertainty of fixed inputs (and the user inputs if no low and high values are entered).

Change in “transport” expenditure (rows 1092:1141)

In the first final output table, total change in travel expenditure per household for annual costs (as calculated in **Calcs-AffordIndiv(Transport)** sheet - step 7) are discounted and deflated for each income quintile and different uncertainty scenarios.

The reference year and the GDP deflator inputs for the different uncertainty scenarios for the discounted cost of the annual and capital transitional change in “transport” expenditure is fed from the GDP deflator fixed input table - **Calcs-AffordIndiv(Transport)** sheet in rows 287:290

Box 104 Discount change to "transport" and "domestic" expenditure over the appraisal period

Final impact output

Description: Change in travel expenditure per household is discounted and deflated (annual and transition costs separately)

Inflation:

Input	Year	Value	Uncertainty score
GDP deflator (2013 = 100)	2013	100.0	2
GDP deflator (2013 = 100)	2014	102.0	

Discount rate: 3.5%

Step outputs:

Output	Units
Discounted value of change in travel expenditure per household	£ 2014
Discounted value of capital transition costs	£ 2014

	2015	2016	2017	2018	2019	2020
Discount factor	1.0000	0.9662	0.9335	0.9019	0.8714	0.8420

Final output 1:

Annual travel expenditure change	Quintile	2015	2016	2017	2018	2019	2020
annual cost due to fuel change							
Central	1st	126	121	117	114	111	108
	2nd	108	103	100	97	95	93
	3rd	104	100	97	95	92	90
	4th	110	106	102	100	97	95
	5th	132	126	122	119	116	113
Low	1st	55	53	51	50	48	47
	2nd	48	46	45	43	42	41
	3rd	46	45	43	42	41	40
	4th	49	48	46	45	43	42
	5th	58	56	54	52	51	49
High	1st	250	243	237	231	225	219
	2nd	219	213	208	204	199	194
	3rd	214	209	204	199	195	191
	4th	227	222	217	212	208	203
	5th	267	261	255	249	243	238

Final output table 2 calculates the total capital investment by aggregating the cost of early purchase with the cost of the car. The total capital investment are then compared with the annual household disposable income to provide the weighted cost in percentage.

Total capital investment: Additional cost of early purchase + cost of the car

2020	Total capital investment in 2020			Weighted cost as percentage of annual household disposable income			Total capital investment in NPV		
Income level	Central	Low	High	Central	Low	High	Central	Low	High
All income levels	11,694.84	9,154	16,687	37%	29%	52%	9,847	7,707	14,050
Lowest real income level	11,782	9,234	16,727	116%	91%	165%	9,921	7,775	14,084
Second level	11,736	9,207	16,590	60%	47%	85%	9,881	7,752	13,968
Third level	11,719	9,199	16,527	43%	34%	60%	9,867	7,745	13,916
Fourth level	11,706	9,156	16,745	31%	24%	45%	9,856	7,709	14,098
Highest real income level	11,599	9,045	16,801	18%	14%	26%	9,766	7,615	14,146

For the total capital investment in NPV, an INDEX MATCH function is used to pick up appropriate discount factor from **Calcs-AffordIndiv(Transport)** (row 1107) for each year. The discount factor is then multiplied by the Total capital investment in 2020 calculated in columns D:F in the final output 2 table.

Change in "domestic" expenditure (rows 630:686)

Total change in energy expenditure per household for annual costs (as calculated in **Calcs-AffordIndiv(Domestic)** sheet - step 7) are discounted and deflated for each income quintile and different uncertainty scenarios.

The reference year and the GDP deflator inputs for the different uncertainty scenarios for the discounted cost of the annual and capital transitional change in "domestic" expenditure is fed from the GDP deflator fixed input table - **Calcs-AffordIndiv(Transport)** sheet in rows 103:106.

Box 104 Discount change to "transport" and "domestic" expenditure over the appraisal period

Final impact output

Description: Change in energy expenditure is discounted and deflated (annual and transition costs separately)

Units: £

Inflation:

Input	Year	Value	Uncertainty score
GDP deflator (2013 = 100)	2014	102.00	2
GDP deflator (2013 = 100)	2014	102.00	

Discount rate: 3.5%

Step outputs:

Output	Units
Discounted value of change in energy expenditure	£ 2014
Discounted value of capital transition costs	£ 2014

	2015	2016	2017	2018	2019	2020
Discount factor	1.0000	0.9662	0.9335	0.9019	0.8714	0.8420

Final output 1:

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	69.2	66.2	65.0	61.7	59.9	56.1
	2nd	71.9	69.7	69.0	65.9	64.4	60.7
	3rd	81.6	78.5	77.2	73.5	71.4	67.1
	4th	90.6	86.8	85.3	81.0	78.5	73.6
	5th	121.8	115.0	111.6	105.1	101.0	94.1
Low	1st	27.6	27.2	27.2	26.2	25.9	24.6
	2nd	31.2	30.8	30.9	29.8	29.4	27.9
	3rd	33.5	33.1	33.2	32.0	31.5	29.9
	4th	36.5	36.0	36.0	34.7	34.2	32.5
	5th	44.0	43.2	43.2	41.6	40.9	38.8
High	1st	113.5	112.0	112.3	108.3	106.8	101.5
	2nd	128.4	126.9	127.4	122.9	121.3	115.2
	3rd	138.0	136.1	136.6	131.7	129.9	123.4
	4th	150.1	148.0	148.4	143.1	141.0	133.9
	5th	180.9	177.7	177.9	171.3	168.5	159.9

In the final output 2 table, the capital transitional costs (as calculated in **Calcs-AffordIndiv(Transport)** sheet- step 11) are discounted and deflated for each income quintile and different uncertainty scenarios.

Final output 2:

Scenario	Quintile	2015	2016	2017	2018	2019	2020
Central	1st	-	-	-	-	-	561.3
	2nd	-	-	-	-	-	561.3
	3rd	-	-	-	-	-	561.3
	4th	-	-	-	-	-	561.3
	5th	-	-	-	-	-	561.3
Low	1st	-	-	-	-	-	1,263.0
	2nd	-	-	-	-	-	1,263.0
	3rd	-	-	-	-	-	1,263.0
	4th	-	-	-	-	-	1,263.0
	5th	-	-	-	-	-	1,263.0
High	1st	-	-	-	-	-	505.2
	2nd	-	-	-	-	-	505.2
	3rd	-	-	-	-	-	505.2
	4th	-	-	-	-	-	505.2
	5th	-	-	-	-	-	505.2

Output qualitative uncertainty score: 4

The outputs of this calculation are the discounted costs for each year of the appraisal period for each uncertainty scenario. These feed into the **Results-AffordIndiv** sheets.

The calculation assessment above (section 9.3) provides the output of the change of transport and domestic expenditure for individuals following implementation of the policy/measure by cost impact and percentage impact of each individual household disposable income. The information is fed directly into the **Results-AffordIndiv** sheet:

Box 105 Results Affordability for individuals (Transport and Domestic) and Results Summary

Results-AffordIndiv presents results for the affordability on individuals in "transport" and "domestic" expenditures, split into costs and benefits, by income quintile and for the assessment years. For each type of expenditure (i.e. transport and domestic), two table of costs and benefits are provided, one for the change in expenditure (tables 1 and 4) and the second as a percentage change in expenditure over the individual's disposable income (tables 2 and 5). Table 3 presents the total capital investment which includes the cost of early purchase with the cost of the car and provides this in NPV terns. This is also compared with the annual household disposable income for the weighted percentage cost. A table of total change in household expenditures summing up the impact from "transport" and "domestic" expenditure in rows 266:328 is provided in table 6. Examples of the six results tables are shown below:

Transport

1. Annual costs/benefits due to change in travel expenditure per household in rows 14:46

The discounted annual travel expenditure changes by income quintiles are calculated in annual costs and benefits per household for the

Box 105 Results Affordability for individuals (Transport and Domestic) and Results Summary

different scenarios. The results presented in the table here are fed from **Calcs-AffordIndiv(Transport)** sheet rows 1110:1124.

Annual costs/benefits due to change in travel expenditure per household

Units:	£ per household		Quintile	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual travel expenditure	Annual cost	Central	1st						108	105	102	100	97	94	92	90	87	85	83
			2nd						93	90	88	86	84	82	80	78	76	74	72
			3rd						90	88	86	84	82	80	78	76	74	72	70
			4th						95	93	91	89	87	85	83	81	79	77	75
			5th						113	111	108	105	103	100	98	96	93	91	89
		Low	1st						47	45	44	42	41	40	39	37	36	35	34
			2nd						41	39	38	37	36	35	34	33	32	31	30
			3rd						40	38	37	36	35	34	33	32	31	30	29
			4th						42	41	40	38	37	36	35	34	33	32	31
			5th						49	48	46	45	44	42	41	40	38	37	36
		High	1st						219	214	208	203	198	193	188	183	179	174	170
			2nd						194	190	185	181	177	173	169	165	161	157	154
			3rd						191	186	182	178	174	170	166	162	158	155	151
			4th						203	199	194	190	186	182	178	174	170	166	163
			5th						238	232	227	222	217	212	207	202	197	193	188
	Annual benefit	Central	1st																
			2nd																
			3rd																
			4th																
			5th																
		Low	1st																
			2nd																
			3rd																
			4th																
			5th																
		High	1st																
			2nd																
			3rd																
			4th																
			5th																

2. Percentage of change in annual travel expenditure over disposable income in rows 48:80

The results presented in the table here are fed from **Calcs-AffordIndiv(Transport)** sheet - step 9 rows 989:1003.

Percentage of change in annual travel expenditure over disposable income

Units:	% of disposable income		Quintile	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Travel expenditure over disposable income	Annual cost	Central	1st						1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
			2nd						0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
			3rd						0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
			4th						0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
			5th						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
		Low	1st						0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%
			2nd						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%
			3rd						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
			4th						0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
			5th						0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
		High	1st						2.5%	2.5%	2.6%	2.6%	2.6%	2.6%	2.7%	2.7%	2.7%	2.7%	2.7%
			2nd						1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.3%
			3rd						0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
			4th						0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
			5th						0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%
	Annual benefit	Central	1st																
			2nd																
			3rd																
			4th																
			5th																
		Low	1st																
			2nd																
			3rd																
			4th																
			5th																
		High	1st																
			2nd																
			3rd																
			4th																
			5th																

3. Transitional (capital) costs for households in transport (i.e. scrappage scheme) in rows 83:92

The results presented in the table here are fed from **Calcs-AffordIndiv(Transport)** sheet, “Final output table”, “Additional cost of early purchase in an average household per quantile (£)” - rows 1079:1087.

Domestic

4. Change in domestic energy expenditure per household (transitional and annual) in rows 96:158

The results presented in the table here are fed from **Calcs-AffordIndiv(Transport)** sheet rows 650:664.

Box 105 Results Affordability for individuals (Transport and Domestic) and Results Summary

Change in domestic energy expenditure per household (transitional and annual)

Units:	£ per household		Quintile	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Costs	Transition cost	Central	1st																
			2nd																
			3rd																
			4th																
			5th																
		Low	1st																
			2nd																
			3rd																
			4th																
			5th																
		High	1st																
			2nd																
			3rd																
			4th																
			5th																
	Annual cost	Central	1st						56	56	54	51	51	49	49	48	47	47	45
			2nd						61	61	59	56	56	54	55	53	52	52	51
			3rd						67	67	65	62	61	59	59	58	56	57	55
			4th						74	73	71	67	67	64	65	63	61	62	60
			5th						94	93	89	84	83	79	79	77	75	75	73
		Low	1st						25	25	24	23	24	23	23	22	22	22	22
			2nd						28	28	28	27	27	26	26	26	25	25	25
			3rd						30	30	30	28	29	28	28	27	27	27	26
			4th						32	33	32	31	31	30	30	30	29	29	28
			5th						39	39	38	37	37	36	36	35	35	35	34
		High	1st						102	103	101	97	97	95	96	93	91	92	90
			2nd						115	116	115	110	111	107	109	106	104	105	102
			3rd						123	125	123	117	118	115	116	113	111	112	109
			4th						134	135	133	127	128	124	126	123	120	121	118
			5th						160	161	158	152	152	148	149	145	143	144	140

5. Percentage of change in domestic energy expenditure over disposable income (transitional and annual) in rows 160:222

The results presented in the table here are fed from:

- **Calcs-AffordIndiv(Domestic)** sheet - step 9 rows 547:561 for annual cost and benefits
- **Calcs-AffordIndiv(Domestic)** sheet - step 11 rows 611:625 for transitional cost and benefits

Percentage of change in domestic energy expenditure over disposable income (transitional and annual)

Units:	% of disposable income		Quintile	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Costs	Transitional cost	Central	1st																
			2nd																
			3rd																
			4th																
			5th																
		Low	1st																
			2nd																
			3rd																
			4th																
			5th																
		High	1st																
			2nd																
			3rd																
			4th																
			5th																
	Annual cost	Central	1st						0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%
			2nd						0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
			3rd						0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
			4th						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
			5th						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
		Low	1st						0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%
			2nd						0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
			3rd						0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%
			4th						0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
			5th						0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
		High	1st						1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.5%	1.5%
			2nd						0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%
			3rd						0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%
			4th						0.4%	0.4%	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
			5th						0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%

Total affordability for individuals

6. Total change in household expenditure per income quintile in rows 225:287

The total change in travel and domestic energy expenditure are summed to provide the total change in household expenditure for individuals and the results presented are fed from:

- Table 1 - **Results-AffordIndiv -** Annual costs/benefits due to change in travel expenditure per household in rows 17:46
- Table 3 - **Results-AffordIndiv** - Transitional (capital) costs for households in transport (i.e. scrappage scheme) in rows 83:92
- Table 4 - **Results-AffordIndiv -** Change in domestic energy expenditure per household (transitional and annual) in rows 88:92

Box 105 Results Affordability for individuals (Transport and Domestic) and Results Summary

Total change in household expenditure per income quintile

For scrappage scheme, only the additional cost associated to early purchase of a car is added. NOT the total cost of the car.

Units:	£ per household		Quintile	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Costs	Transition cost	Central	1st	-	-	-	-	-	1,017	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	1,003	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	1,003	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	905	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	737	-	-	-	-	-	-	-	-	-	-
		Low	1st	-	-	-	-	-	797	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	786	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	787	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	708	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	575	-	-	-	-	-	-	-	-	-	-
		High	1st	-	-	-	-	-	1,443	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	1,417	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	1,415	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	1,295	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	1,068	-	-	-	-	-	-	-	-	-	-
	Annual cost	Central	1st	-	-	-	-	-	164	161	157	151	148	144	141	137	134	132	128
			2nd	-	-	-	-	-	153	151	147	142	140	136	135	131	128	126	123
			3rd	-	-	-	-	-	157	155	151	145	143	139	137	133	130	129	125
			4th	-	-	-	-	-	169	166	162	156	154	149	147	143	140	139	135
			5th	-	-	-	-	-	208	204	197	189	186	180	177	172	168	166	161
		Low	1st	-	-	-	-	-	71	70	68	66	65	63	62	60	58	57	56
			2nd	-	-	-	-	-	69	68	66	64	63	61	60	58	57	56	54
			3rd	-	-	-	-	-	70	69	67	65	64	62	61	59	58	57	55
			4th	-	-	-	-	-	75	74	72	69	68	66	65	64	62	61	59
			5th	-	-	-	-	-	88	87	85	82	80	78	77	75	73	72	70
		High	1st	-	-	-	-	-	321	316	309	300	295	287	284	276	270	266	259
			2nd	-	-	-	-	-	310	306	300	291	287	280	277	271	265	262	255
			3rd	-	-	-	-	-	314	311	305	295	292	284	282	275	269	266	260
			4th	-	-	-	-	-	337	334	327	317	314	306	304	296	290	287	280
			5th	-	-	-	-	-	398	394	385	373	369	359	356	347	340	337	328
Benefits	Transition benefits	Central	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Low	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		High	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual benefit	Central	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Low	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		High	1st	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3rd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			4th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			5th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The summary of the results for the assessment of affordability for individuals is presented in **Results-Summary.**

Box 106 Results-Summary Affordability for individuals

Data is imported from the **Results-AffordIndiv** sheet – Impact to society/individual – Total change in household expenditure per income quintile (rows 266:328) where the appraisal years are summed and presented in the **Results-Summary** rows 101:111 where the net present value on the costs and benefits as a result of policy/measure implementation for the affordability for individuals are calculated. The figure below shows an example of the final summary results.

Affordability for individuals

npv per income quintile 2014 prices £'000s	Costs									Benefits									Total Net Present Value			Comments
	Total Transition			Average Annual			Total costs			Transition benefit			Annual benefit			Total benefits						
	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	Central	Low	High	
1st	1.0	0.8	1.4	1.6	0.7	3.2	2.6	1.5	4.6	0	0	0	0	0	0	0.0	0.0	0.0	2.6	1.5	4.6	For capital cost of transport (i.e. car scrappage scheme) only the additional cost of early purchase is considered here. NOT the total cost of the car. For results considering total capital investment, please see the detailed impacts sheet.
2nd	1.0	0.8	1.4	1.5	0.7	3.1	2.5	1.5	4.5	0	0	0	0	0	0	0.0	0.0	0.0	2.5	1.5	4.5	
3rd	1.0	0.8	1.4	1.5	0.7	3.2	2.5	1.5	4.6	0	0	0	0	0	0	0.0	0.0	0.0	2.5	1.5	4.6	
4th	0.9	0.7	1.3	1.7	0.7	3.4	2.6	1.4	4.7	0	0	0	0	0	0	0.0	0.0	0.0	2.6	1.4	4.7	
5th	0.7	0.6	1.1	2.0	0.9	4.0	2.7	1.4	5.1	0	0	0	0	0	0	0.0	0.0	0.0	2.7	1.4	5.1	
Average impact	0.93	0.73	1.33	1.66	0.73	3.36	2.60	1.46	4.69	-	-	-	-	-	-	-	-	-	2.60	1.46	4.69	

10.5 Limitations

- Public transport policies tend to have very localised impacts, their affordability will vary heavily for different people due to changes in concessionary rates, travel card rates etc. Since this model is designed to look at the impact of national scale policies on individuals, its applicability to localised public transport schemes is limited.
- The model provides high level assessment of potential impacts on affordability. As such it does not allow detailed distributional assessment of the impacts on the specific population groups other than based on the income (e.g. by age, region, gender).
- The method combines inputs from different surveys, primarily the ONS Family Spending Survey and the National Transport Survey. This approach has been consulted with a statistician at the Department for Transport who advised that while there may be some differences between income groups in these sources, the samples for both surveys are designed to represent the overall population; hence it is acceptable to combine these sources for the purpose of this high-level assessment.
- The results present to what extent households in different income quintiles would be affected by the policy. It does not however present how many households would be affected by the policy. Such functionality would require detailed information on the differences in housing stock in the UK per different income quintiles and hence would greatly increase complexity of the model. If the results of the assessment using the wider impacts model show that policy may not be affordable for households in specific income groups, a more detailed independent assessment of the impact should be undertaken outside of the wider impacts model. DIMPSA model used by DECC for the purpose of assessing distributional impacts of policies could be a potential tool to be used for this purpose.
- The method used has been developed specifically for the purpose of the wider impacts model. While the comparison of scenario and counterfactual costs forms core of methods used in other tools assessing distributional impacts on households (e.g. DIMPSA model), the method is not directly comparable with methods used elsewhere.
- The results of the assessment present possible impact on average household in each income quintile – the concept of average household has been described in the introduction of the impact. As such real impacts across households in a specific income quintile may be higher or lower than presented by the model results. For example if a policy affects prices of diesel, households in each income quantile which do not own a diesel car would not be affected and hence there would be no impact on their affordability (impact will be lower than presented in the results). On the other hand, if a household owns more than an average number of diesel cars, the real impact on household's affordability may be higher than presented by the model.
- Due to the limitations above, the results should primarily be used to identify whether a policy is likely to have disproportionate impact on a specific income group. The model takes into consideration differences between income quintiles (e.g. in average car ownership, average consumption of energy, average use of public transport) however it does not provide further disaggregation of the results on specific user groups in a given income quintile (e.g. households with or without a car, households using gas for space heating, households using electricity for space heating etc.). It should therefore be primarily used a screening tool to establish whether distributional impacts of the policy assessed should be investigated in more detail.

11. Measuring uncertainty

Two different systems are used to assess uncertainty:

The quantitative system is based on three uncertainty scenarios: central (or best), low and high estimates. If data are entered for all three scenarios in the relevant control sheet, the results will display the final impact for each scenario. The low and high values will provide an indication of the uncertainty range associated with the central (or best) estimate. In most cases, the same calculations will be applied to the three scenarios and the difference in the results will be only due to the different user inputs. However, in those cases where fixed inputs are available for different uncertainty scenarios (e.g. future energy and carbon prices for the assessment of GHG) the difference between scenarios also considers different fixed inputs.

The qualitative scenario is based on uncertainty indicators attributed to each of the inputs. Every fixed input has a qualitative uncertainty category associated with it (low, medium or high). These have been assigned by default by the developers of the model but can be changed in the relevant input sheets using a drop down menu. Scores linked with these categories are carried through the calculations and a weighted system displays the uncertainty category associated with the final results. If quantitative low and high inputs values are not entered, then a qualitative uncertainty indicator should be selected when entering the central estimate for the variable inputs. In that case, the final uncertainty indicator reflects the combined uncertainty associated with user and fixed inputs as a whole. The qualitative uncertainty system can also be used in combination with the quantitative one as a supporting measurement of uncertainty.

Qualitative scores are assigned to each input based on the following categories:

- Not used (Score: 1)
- Low (Score: 2)
- Medium (Score: 3)
- High (Score: 4)

These scores are carried through each step of the calculations according to the intervening operations so they increase proportionally to the complexity of the calculations and the number of inputs and steps. For example, if two inputs are summed then their associated uncertainty scores are also summed. If one input is divided by another, their associated scores are multiplied. Following this approach, a final qualitative uncertainty score is assigned to the outputs of each impact.

Box 107 Weighting results uncertainty

In order to assign each final score to a meaningful category, two sensitivity analysis were conducted. In the first one, all the uncertainty scores for both user and fixed inputs were assigned the same category. This was done for the four available categories (i.e. all low, all central, etc) and the resulting score for each output was recorded.

1. All user and fixed inputs set to the same uncertainty scenario

Impact	Output	Not used	Low	Medium	High
Congestion	Congestion	1	16	81	256
Noise	Noise	1	16	81	256
Accidents	Accidents	1	16	81	256
Modal shift	Change in number of trips per year	1	8	27	64
	Total change in number of trips for the whole appraisal period	1	8	27	64
Health impacts	Impact to society / individual - Modal shift approach: Cycling	1	4,096	531,441	16,777,216
	Impact to society / individual - Modal shift approach: Walking	1	4,096	531,441	16,777,216
	Impact to society / individual - Standalone approach: Cycling	1	16,384	4,782,969	268,435,456
	Impact to society / individual - Standalone approach: Walking	1	16,384	4,782,969	268,435,456
GHG	Net carbon emissions in ktonnes CO2e	1	4	9	16
	Discounted monetised value of carbon emissions	1	16	81	256

Box 107 Weighting results uncertainty

	Discounted monetised value of change in energy consumption	1	16	81	256
	Discounted monetised value of rebound effects	1	16	81	256
	Total monetised impact	3	48	243	768
Business affordability	Impact on affordability for businesses	2	96	972	5,120
Employment	Impact on employment at division level	7	2,176	67,797	802,816
Affordability for individuals	Transport qualitative uncertainty score:	5	184	2,529	17,696
	Domestic energy qualitative uncertainty score:	3	104	999	5,184
	Total change in household expenditure per income quintile	8	288	3,528	22,880

Current fixed inputs are generally reliable, with relatively low qualitative uncertainty scores being awarded by default. It was assumed that potential future updates of fixed inputs are also likely to be based on reliable data. Therefore, the values for the medium and high scenarios from the table above are likely to be overestimated as reaching such values will be very improbable. A second sensitivity test was conducted assuming that uncertainty scores from fixed inputs stay as default and only scores from user inputs are changed to each of the uncertainty categories.

2. Only user inputs set to the same uncertainty scenario (fixed inputs set as default)

Impact	Output	Not used	Low	Medium	High
Congestion	Congestion	18	36	54	72
Noise	Noise	18	36	54	72
Accidents	Accidents	18	36	54	72
Modal shift	Change in number of trips per year	9	18	27	36
	Total change in number of trips for the whole appraisal period	9	18	27	36
Health impacts	Impact to society / individual - Modal shift approach: Cycling	216	6,912	52,488	221,184
	Impact to society / individual - Modal shift approach: Walking	216	6,912	52,488	221,184
	Impact to society / individual - Standalone approach: Cycling	24	12,288	472,392	6,291,456
	Impact to society / individual - Standalone approach: Walking	24	12,288	472,392	6,291,456
GHG	Net carbon emissions in ktonnes CO2e	2	5	7	9
	Discounted monetised value of carbon emissions	14	27	41	54
	Discounted monetised value of change in energy consumption	15	30	45	60
	Discounted monetised value of rebound effects	15	30	45	60
	Total monetised impact	44	87	131	174
Business affordability	Impact on affordability for businesses	32	96	192	320
Employment	Impact on employment at division level	152	2,176	14,328	61,952
Affordability for individuals	Transport qualitative uncertainty score:	160	384	752	1,264
	Domestic energy qualitative uncertainty score:	74	224	450	752
	Total change in household expenditure per income quintile	234	608	1,202	2,016

In order to account for the two tests and to avoid underestimating uncertainty in the low scenario and overestimating in the medium and high ones, the maximum value between the two tests for the low scenario was used as the boundary between low and medium for each output. The maximum value between the two tests for the medium scenario was considered the boundary between medium and high. The final values used to categorise the qualitative uncertainty category of results is displayed below.

Box 107 Weighting results uncertainty

Ranges for the classification of final uncertainty

Figures calculated after calibration of qualitative uncertainty scoring. See technical specification for details.

Impact	Output	Boundary low-medium	Boundary medium - high
Congestion	Congestion	36	54
Noise	Noise	36	54
Accidents	Accidents	36	54
Modal shift	Change in number of trips per year	18	27
	Total change in number of trips for the whole a	18	27
Health impacts	Impact to society / individual - Modal shift appro	6912	52488
	Impact to society / individual - Modal shift appro	6912	52488
	Impact to society / individual - Standalone appro	16384	472392
	Impact to society / individual - Standalone appro	16384	472392
GHG	Net carbon emissions in ktonnes CO2e	4.5	6.75
	Discounted monetised value of carbon emissior	27	40.5
	Discounted monetised value of change in energ	30	45
	Discounted monetised value of rebound effects	30	45
	Total monetised impact	87	130.5
Business affordability	Impact on affordability for businesses	96	192
Employment	Impact on employment at division level	2176	14328
Affordability for individuals	Transport qualitative uncertainty score:	384	752
	Domestic energy qualitative uncertainty score:	224	450
	Total change in household expenditure per inco	608	1202

This table is presented in **Inputs-Common data** (rows 127:146) and can be modified by the user in order to apply a different set of intervals.

Appendix A
Geographic areas used in the assessment of traffic related impacts

The geographic areas used in the assessment of traffic related impacts (i.e. congestion, noise, accidents, modal shift) are based on the areas used in WebTAG Table A5.4.1 “Traffic by region, congestion band, area type & road type”. The data for the reference WebTAG table have been derived from the DfT’s National Transport Model.

Table A1 below presents the geographic areas used in the Wider Impacts Model and format of fixed inputs to the model (WebTAG Table A5.4.1). No additional assumptions concerning geographic areas have been made within the Wider Impacts Model.

Table A1 Geographic areas used in the Wider Impacts Model

Areas used in the Wider impacts model (following WebTAG Table A5.4.1)
East Midlands
East Anglia
London
North East
North West
Scotland
South East
South West
Wales
West Midlands
Yorkshire and The Humber
Great Britain
England and Wales
England

Appendix B
Assumptions on vehicle types and fuels used in the assessment of greenhouse gases

The categories of passenger vehicle types and fuels used in the assessment of greenhouse gases is determined by the emission factors used for this purpose in the wider impacts model. The assumptions underlying the emission factors are presented in the DECC (2014) "Government GHG Conversion Factors for Company Reporting"[20]. Table B1 below presents key information on the vehicles sub-types and fuels used in the Wider Impacts Model based on the information in DECC (2014).

Table B1 Assumptions on vehicle types and fuels used in the assessment of greenhouse gases

Type of vehicle	Vehicle sub-type	Fuel type	Description
Cars	Small car	Petrol	Cars with engine size <1.4l
		Diesel	Cars with engine size <1.7l
		Hybrid	Emission factor is the weighted average of petrol/electric and diesel/electric hybrid cars. Boundaries of engine size not defined in the reference source
		Unknown	Boundaries of engine size not defined in the reference source
Cars	Medium car	Petrol	Cars with engine size 1.4l - 2.0l
		Diesel	Cars with engine size 1.7l-2.0l
		Hybrid	Emission factor is the weighted average of petrol/electric and diesel/electric hybrid cars. Boundaries of engine size not defined in the reference source
		CNG	Boundaries of engine size not defined in the reference source
		LPG	Boundaries of engine size not defined in the reference source
		Unknown	Boundaries of engine size not defined in the reference source
Cars	Large car	Petrol	Cars with engine size greater than 2.0l
		Diesel	Cars with engine size greater than 2.0l
		Hybrid	Emission factor is the weighted average of petrol/electric and diesel/electric hybrid cars. Boundaries of engine size not defined in the reference source
		CNG	Boundaries of engine size not defined in the reference source
		LPG	Boundaries of engine size not defined in the reference source
		Unknown	Boundaries of engine size not defined in the reference

[20] http://www.ukconversionfactorscarbonsmart.co.uk/documents/2014%20Emission%20Factor%20Methodology%20Paper_FINAL-4Jul14.pdf

Type of vehicle	Vehicle sub-type	Fuel type	Description
			source
Cars	Average car	Petrol	Average car emissions by fuel type weighted using relative number of registrations.
		Diesel	
		Hybrid	
		CNG	
		LPG	
		Unknown	
		Electric	
Motorbike	Small motorbike	Petrol	Mopeds/scooters up to 125cc
Motorbike	Medium motorbike	Petrol	125 - 500cc
Motorbike	Large motorbike	Petrol	Over 500cc
Motorbike	Average motorbike	Petrol	Average motorbike emissions weighted using relative number of registrations.
Taxis	Regular taxi	Assumed diesel	Assumes average emissions from medium/large vehicle and a passenger occupancy of 1.4
Taxis	Black cab	Assumed diesel	Average passenger occupancy of 1.5
Bus	Local bus (not London)	Assumed diesel	Passenger occupancy of 9.5
Bus	Local London bus	Assumed diesel	Passenger occupancy of 16.8
Bus	Average local bus	Assumed diesel	Passenger occupancy of 10.8
Bus	Coach	Assumed diesel	Passenger occupancy of 16.2
Rail	National rail	Mixed diesel / electricity	Emission factor is based on average emission per passenger kilometre for diesel and electric trains in 2012-13
Rail	Light rail and tram	Electricity	Average emissions based on the following light trains (DLR (Docklands Light Rail), Glasgow Underground, Midlands Metro, Tyne & Wear Metro, London Overground) and trams (Croydon Tramlink, Manchester Metrolink, Nottingham Express Transit, Supertram).
Rail	London Underground	Electricity	Average emissions per passenger as provided by TfL