Carbon Impact Assessment

Reporting requirements for Stage 2

June 2022

1. Introduction

The purpose of this note is to improve the accessibility and ease of use of the carbon impact assessment methodology outlined in the technical guidance provided by the consultants on the carbon impact assessment project. This technical guidance covers carbon impact assessment as Outline Business Case (OBC) and Full Business Case (FBC) and is referred to in this document as 'Stage 2 Guidance'. This reporting requirements note supports the Stage 2 Guidance by:

- Providing promoters with more prescriptive advice on what they should include in their carbon impact assessment and how this should be done
- Making it clear what the minimum requirement for reporting is and providing a pro forma for promoters to use to communicate the results of their carbon impact assessment

This should make is easier for promoters to fulfil their obligations under carbon impact assessment. It should also improve the auditability of such assessments.

This note has been developed after further consultations on the methodology and its practical application with promoters and other stakeholders. It also takes other relevant technical guidance into account. Some links are provided in the text and a list of references is provided at the end of this note.

2. Minimum Requirement

The minimum requirement for a carbon impact assessment is to carry out the analyses necessary to complete the pro forma given in this note in accordance with the advice provided. A carbon impact assessment will be required for each option in the short list for which detailed economic assessment is being carried out.

Pro formas will need to be provided for all the options subject to detailed analysis and for transport schemes for both the 'core' scenario and the 'low carbon' scenario for each option. For transport schemes a greenhouse gases workbook should be provided (as described in Department for Transport, Transport Analysis Guidance (TAG) Unit A3) to match each pro forma.

Promoters should provide their working (in the form of spreadsheets etc.) in sufficient detail that the carbon impact assessment process can be audited by PMA along with the rest of the Business Case submission.

Optionally, promoters can complete the more detailed pro forma given in the Stage 2 Guidance for the same options/scenarios. This would be in addition to the minimum requirement stated above.

Promoters may be expected to carry out a more detailed carbon impact assessment if their project is likely to have a significant carbon impact or the carbon impact of the proposal is likely to come under particular scrutiny. Promoters should contact the PMA if they think their project might fall into these categories. The more detailed carbon impact assessment will need to include completed pro formas as specified above in the minimum requirement.

3. General Notes

3.1 Carbon values

Carbon should be expressed in tCO2e. A negative value should be used to indicate a **reduction** in emissions, a positive value an **increase** in emissions. Care should be taken to make sure any description attached to a carbon value is clear in terms of what it means in terms of an increase or a reduction in emissions.

3.2 The 'without scheme' and 'with scheme' cases

The 'without scheme' case is sometimes referred to as 'business as usual' and is the benchmark against which different interventions are measured. The 'with scheme' case is the intervention that is being considered and therefore being compared with the 'without scheme' case. The carbon impact of an intervention is the difference between the carbon impact of the 'without scheme' case and the carbon impact of the 'with scheme' case. As noted above, an intervention which results in a reduction in emissions ('without scheme' emissions > 'with scheme' emissions) should be represented as having negative carbon emissions.

The 'without scheme' case will be the same for all the options being considered. The 'with scheme' case describes the option being considered, it may be the preferred option or one of the other options on the short list.

Both the Green Book and Better Business Cases guidance use 'business as usual' and the Green Book also uses 'counterfactual' to describe the 'without scheme' case. They both also suggest that 'do minimum' can be a legitimate option for the intervention (so a 'with scheme' case). DfT TAG uses the terms 'with scheme' and without scheme' (as here). The Transport User Benefit Appraisal (TUBA) software recommended by DfT uses the terms 'do-something' (DS) and 'do-minimum' (DM) in its user manual and output files for 'with scheme' and 'without scheme' cases respectively. 'Do nothing' is also sometimes used to describe the 'without scheme' case.

Clarity over both the 'with scheme;' and 'without scheme' cases is important because the carbon impact of an intervention is a net impact and therefore depends on both cases.

3.3 Scenarios

Scenarios or sensitivity tests represent different assumptions about what will happen in the future, they are designed to test how an option performs under different future conditions. A 'low carbon' transport scenario has been developed from the models used for the Carbon Emission Reduction Pathways (CERP) work to test how transport proposals performs against background assumptions which are more consistent with the West Yorkshire target of net zero carbon emissions by 2038. This specifies a set of assumptions about traffic growth/reduction and take-up of electric vehicles different from the assumptions used in the 'core' scenario specified by DfT. For transport schemes, the carbon impact should be reported for both the 'core' scenario and the 'low carbon' scenario for each of the options (different 'with scheme' cases) being considered. This will require several pro formas to be filled in (one for each option under each scenario), but much of the information required will be similar across a number of these pro formas.

3.4 Reporting of total carbon emissions up to dates

In the pro forma described below, both the capital and operational carbon emissions and broken down into the amount emitted up to certain dates. This is to allow monitoring against relevant target dates. If promoting organisations have target dates which are different from those given, these can be added to the pro forma, but the 2030, 2038, 2050 and total figures should always be reported. Note that the totals up to dates should be the total carbon emissions associated with the intervention up to the end of the given year, so the 2038 total will include emissions up to 2030 (plus emissions in 2031 to 2038 inclusive).

Note that this does not imply a monitoring requirement. Any monitoring of impacts/outcomes associated with carbon impact should be outlined in the monitoring and evaluation plan.

3.5 Whole Life Carbon reporting in TAG

TAG Unit A3 now specifies that the assessment of greenhouse gas emissions should include carbon emissions over the whole lifecycle of a transport scheme. This should include 'those resulting from the production of materials used in any infrastructure, for example cement, steel etc (otherwise known as

capital carbon), as well as those resulting from changes to the use of transport fuels.' It goes on to suggest that such a whole life carbon (WLC) assessment should include:

> '**capital carbon** (emissions associated with scheme construction), **operational carbon** (emissions associated with scheme operation and maintenance), and **user carbon** (emissions associated with scheme users, such as changes in emissions due to mode shift).'

For the purposes of this guidance capital (or embodied) carbon is the (change in) emissions associated with the construction and maintenance of the scheme. Operational carbon is the (change in) emissions associated with the use of the scheme. For a transport scheme, operational carbon will be the changes in user emissions as a result of the changes the intervention has made to the transport system, these may be due to more efficient traffic behaviour, rerouting, mode shift etc. Changes in operational carbon can be calculated using a transport model, though transport models will differ in their treatment of the various behavioural responses that might occur because of a transport intervention.

TAG Unit A3 specifies that monetary valuation of carbon impact should extend over the whole lifecycle of the transport scheme and that these emissions should be disaggregated into those from the 'traded' and 'non-traded' sectors. The representation of the valuation of changes in carbon emissions in the economic assessment are different for emissions from the different sectors. The distinction between traded and non-traded carbon should be preserved in the reporting in the pro forma outlined below to allow comparison with other elements of the assessment of the scheme, for instance the greenhouse gases worksheet and the economic assessment.

4. Pro Forma

The different parts of the pro forma are described below with explanatory notes where required. Copies of the complete pro formas for non-transport and transport schemes are given in Appendix A and B

4.1 General Information

Name of scheme	As in PIMS
Type of scheme	Refer to the scheme typology in Stage 2 Guidance
Scheme opening year	
Appraisal period	The length of time over which the effect of the intervention is being assessed. Report the start date (which should match the opening year), end date (year) and number of years. For a transport scheme the appraisal period is typically 60 years.
Brief description of the 'without scheme' case	What are we comparing this option for this scheme against? See note A below
Brief description of the 'with scheme' case	What does this option for this scheme involve? See note A below
Total scheme cost	Cost of this option for this scheme See note B below

The information given should match that given elsewhere in the business case unless otherwise noted and explained.

A: Brief descriptions of the 'without scheme' and 'with scheme' cases

Each case should be described briefly. For transport projects the 'without scheme' case is likely to simply be the existing transport network ('business as usual'), though different assessments might consider alternative scenarios with/without a significant complementary scheme. For other types of project, the 'without scheme' case might not be so straightforward. For instance, for a flood prevention measure the 'without scheme' case might include a higher number of flood events (and their carbon impacts) to allow an appropriate comparison with a 'with scheme' case which reduces the risk of flooding. For a housing scheme, the 'without scheme' case might include housing development corresponding to what is likely to happen if the 'with scheme' housing development does not go ahead. This could involve considering whether housing development might be displaced elsewhere and/or dispersed to smaller scale developments. It could also involve housing developed to a lower standard and with fewer 'low carbon' elements than might be achieved in the 'with scheme' case (if this is a requirement of the intervention).

Both the 'with scheme' and the 'without scheme' case descriptions should match those used elsewhere in the business case. If this is not the case, this should be made clear, and a justification given for the discrepancy. If the 'without scheme' case is different from that used elsewhere in the business case, the carbon impact described will not be consistent with the benefits claimed elsewhere in the business case.

B: Total scheme cost

This is used to calculate the carbon intensity of the proposal reported below. Normally this should be the total cost of the scheme (not just the Combined Authority contribution or the cost of the scheme to the public sector). This would normally be the costs incurred in implementing the 'with scheme' case over and above the costs associated with the 'without scheme' case and is therefore the net costs associated with the intervention which leads to the change in carbon emissions described in the pro forma. Where this is not the case this should be highlighted here and noted and explained in the 'Notes' section at the end of the pro forma.

4.2 Background assumptions

Background assumptions	See note C below

C: Background Assumptions

These are assumptions made about the future which apply over the appraisal period. These are assumptions which are unaffected by the scheme and therefore apply equally to both the 'with scheme' and 'without scheme' cases. Assumptions which have significant implications for the carbon impact of the scheme should be identified and their justification and/or the source of the information given together with an indication of the trend. A non-transport example might be a background assumption about the future carbon intensity of grid electricity which might be necessary to calculate the carbon emissions associated with a scheme which reduces the amount of electricity consumed.

4.2.1 Background assumptions for transport schemes

Scenario	See note D below
Background assumptions	See note D below

D: Scenario and background assumptions

Transport schemes should be assessed against both the DfT 'core' scenario (or whatever standard scenario has been selected for the 'core' economic assessment) and the 'low carbon' scenario which includes different forecasts of traffic growth/reduction (by mode) and fleet mix. Fleet mix in this context means the proportions of different types of propulsion (petrol/diesel/electric) within each vehicle type.

For the ‘core’ scenario background assumptions about traffic growth/reduction and fleet mix (propulsion type) should be reported plus any others which may be relevant.

The traffic growth/reduction forecasts being used should be disaggregated for all modes which are relevant to the calculation of operational carbon (see operational carbon details below). Thus, if the operational carbon calculations consider impacts on cycling, walking, public transport and general traffic, then background assumptions about how use of all these modes is going to change over the appraisal period should be stated. This should be in terms of percentage change over a given time period for each mode.

If TUBA or another method consistent with the TAG Databook is being used to calculate the carbon emissions (see below), then the fleet mix (propulsion type) assumptions are as detailed in TAG Databook Table A1.3.9 and this can simply be stated.

If the ‘low carbon’ scenario is used, then the background assumptions for both traffic growth and fleet mix (propulsion type) are those within that scenario and this can simply be stated.

The ‘low carbon’ scenario is available from Research and Intelligence at the Combined Authority.

4.3 Capital carbon emissions

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
The sources of emissions included in the assessment (use multiple lines if necessary)	The method used for calculating the capital carbon (see Stage 2 Guidance)				

The methodology for calculating the capital carbon emitted from interventions is described in the Stage 2 Guidance.

New lines can be inserted into this part of the pro forma if multiple sources need to be described and reported separately (e.g., carbon emissions associated with the materials used, transport, earth moving, maintenance of the scheme etc.).

Note that the majority of the capital carbon will be emitted during construction and therefore the figures given in the dated boxes (after the first one) will differ only by the carbon emissions associated with maintenance of the scheme between the relevant dates.

For transport schemes carbon emissions from ‘traded’ and ‘untraded’ sectors should be reported separately, see TAG Unit A3.

4.4 Modelling approach

Modelling approach	See note E below

E: Description of the modelling approach

The modelling approach is the methodology used to model the effect of the intervention on use and therefore used to calculate the operational carbon emissions from the intervention.

For non-transport schemes a variety of different techniques could be used to model changes in the carbon impact resulting from the use of the intervention. These could include the carbon reductions associated with reduced space heating requirements as a result of a programme of home insulation improvements. Given

the wide variety of different types of non-transport project it is difficult to be specific about possible modelling approaches, but the description should include a brief overview of the methodology and the behavioural responses which are covered in the modelling approach used.

For transport schemes, the modelling approach used will be the same as that used for the economic assessment of the scheme. All that is required here is a brief statement of the features of the modelling approach which are relevant to carbon impact assessment. For the purposes of carbon impact assessment, the different types of model are:

- Simple junction model – a model of an affected junction or small section of the relevant part of the network which is not capable of properly representing reassignment (rerouting) or induced demand.
- Reassignment model – a model which represents rerouting, but still assumes that demand is unaffected by the intervention. Such a model might use a 'fixed trip matrix' assumption, that is that the number of trips by each mode between each origin and destination pair remain unchanged.
- Variable demand model – a model which represents changes in demand for different modes. If a variable demand model has been used, then the scope of representation of changes in demand should be explained (e.g., mode shift, land use change etc.).

In the same way as for the economic assessment, model results from different runs will need to be considered to derive the net changes for the different options under the different scenarios used (including the 'low carbon' scenario).

The information provided should be sufficient to make it clear what changes in demand induced by the intervention have been modelled, that is whether any changes in the overall numbers of trips or the modes used have been modelled. These induced changes in demand will not have been modelled if a simple junction model or reassignment model has been used which makes a 'fixed trip matrix' assumption. This 'induced demand' or 'induced traffic' can be broadly defined as 'the increment in new vehicle traffic that would not have occurred without the improvement of the network capacity' (See Latest evidence on induced travel demand: An evidence review). In terms of economic assessment, the impact of induced traffic can be mixed - while the extra traffic can reduce the benefits for existing traffic, there may be additional benefits associated with the trips that are 'induced'. For carbon impact assessment, the effect of induced traffic is entirely adverse. This is the reason why it is important to be clear about this aspect of the transport modelling.

If induced demand has been omitted, Stage 2 Guidance includes a methodology for estimating the carbon impact of this using a relatively crude elasticity-based approach. If this has been used it should be noted in this section and the results reported under a separate line in the operational carbon results box below.

Induced demand may be a feature of non-transport schemes as well, for instance higher standards of insulation might make space heating cheaper and therefore induce users to increase the temperature or extend the times they use heating systems. If such a behavioural change is felt to be significant, then it should be considered and noted here.

Different approaches to modelling may be used for different elements of the scheme. For transport schemes, different models may be used for active modes, public transport, general traffic etc. Some of these expect induced demand to be considered, for instance uplift in cycling is an input to the Active Mode Appraisal Toolkit (AMAT). Approaches from different elements should be identified separately by creating extra lines in the pro forma and these should match the results reported in the operational carbon results box below.

4.5 Operational carbon

Scope/Source	Carbon calculation methodology	Total carbon emissions (tCO2e)			
		Up to end 2030	Up to end 2038	Up to end 2050	Over whole appraisal period

The sources of emissions included in the assessment (use multiple lines if necessary)	The method used for calculating the operational carbon (see Stage 2 Guidance)				

As described in the Stage 2 Guidance, this is the carbon associated with the operational use of the intervention.

New lines should be inserted into this part of the pro forma if multiple sources need to be described and reported separately (e.g., carbon emissions associated with the heating of a building, appliances used by the occupants, transport associated with trips to and from the new building etc.).

4.5.1 Operational carbon for transport schemes

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
See note F below	See note G below				

For transport schemes carbon emissions from 'traded' and 'untraded' sectors should be reported separately, see TAG Unit A3.

F: Scope/source

New lines should be inserted into this part of the pro forma if multiple sources need to be described and reported separately. These should match the sources of benefit or separately modelled elements of the scheme and should be identified in the Scope/source column. These could include:

- Active modes – any changes in carbon emissions from general traffic which result from mode shift to/from cycling and walking caused by an intervention which affects the provision for these modes.
- Public transport – any changes in carbon emissions from general traffic which result from mode shift to/from public transport caused by an intervention which affects public transport provision.
- Impacts on general traffic – any changes in carbon emissions from general traffic caused by an intervention which affects the provision for general traffic.

Care should be taken to avoid double counting. If there are any other elements of the intervention which might cause increases or reductions in carbon emissions which can be quantified, these should be noted here. These could include significant tree planting or operational carbon saving enhancements which are not included above.

G: Carbon calculation methodology

For each source of carbon identified, the calculation methodology used should be specified.

For active mode schemes assessed using the Active Mode Appraisal Toolkit (AMAT), the impact of the intervention in terms of changes in car kilometres can be extracted from the spreadsheet and used to calculate the carbon impact of the intervention by using the information in the TAG Databook. This is as described in Stage 2 Guidance.

If the impact of a public transport intervention in terms of car kilometres can be calculated, then the carbon impact can be determined in a similar way. In addition, if the intervention has a direct carbon impact (perhaps in terms of changes to service patterns) which can be calculated, this should also be included.

If the scheme affects general traffic, then a result from a TUBA calculation should be reported here. If TUBA has not been used to process transport model results, then the results of a similar calculation using the same TAG based assumptions should be provided.

For the ‘low carbon’ scenario, a version of the TUBA economics file with the relevant adjustment to fleet mix will be provided to promoters to ensure they can carry out the necessary TUBA calculation.

It is recognised that TUBA is a relatively crude method of calculating carbon emissions from model results. However, there are several reasons for specifying a TUBA based calculation for all schemes affecting general traffic:

- TUBA based calculations are already done for most schemes which have impacts on general traffic to derive the economic assessment tables required for the economic case. Using TUBA for carbon calculations ensures that the carbon impact assessment is consistent with the economic assessment.
- Use of a standard approach for all schemes affecting general traffic means that the results can be compared across different schemes
- The methodology is transparent and based on the information given in the TAG Databook
- The results can easily be extracted and reported in the pro forma in the format required and are also compatible with the requirements for the inputs to the TAG greenhouse gases workbook
- It provides comprehensive consideration of all trips on the modelled network, is relatively easy to use and is well known to the transport modelling community
- It is relatively easy to modify the fleet mix assumption in the TUBA economics file to allow the ‘low carbon’ scenario to be used

TAG Unit A3 states that ‘if TUBA is being used to estimate the change in carbon dioxide emissions it is essential that all 8760 hours of the year are represented in the analysis.’ This is to ensure that all carbon dioxide emissions (whenever they happen) are included in the assessment, and it is equally important to represent all the parts of the network which have been affected by the intervention. This is because, unlike emissions which affect air quality, carbon dioxide acts on a global scale and over long timescales so it doesn’t matter where or when carbon dioxide is emitted. While modelling over the entire 8760 hours of the year might be the ideal, it is more usual for transport models to represent only certain time periods when the differences between the performance of the network in the ‘without scheme’ and ‘with scheme’ cases is likely to be greatest. This captures most of the net impacts of the intervention, given that this is the difference between the performance of the ‘with scheme’ and ‘without scheme’ cases. For the same reason the difference between the carbon emissions of the ‘with scheme’ and ‘without scheme’ cases outside the modelled periods is likely to be small as long as the effect of the intervention on traffic behaviour in these periods is small.

The modelled time periods which have been fed into the TUBA calculations should therefore be noted here. Where there is felt likely to be a difference between the carbon emissions from the ‘with scheme’ and ‘without scheme’ cases outside these time periods (and therefore omitted from the TUBA calculation) this should be noted. If this difference is likely to be large, then measures to estimate the difference in carbon emissions in the periods should be undertaken. These could include extending the modelled periods or estimating emissions from unmodelled periods using information from periods which have been modelled (for instance by using the interpeak model results to estimate the performance of the intervention at weekends). Note that if traffic behaviour differs between ‘with scheme’ and without scheme’ cases in unmodelled periods then this will affect the other modelled impacts of the scheme, as well as the carbon emissions.

There is a further discussion of this issue and the advantages and disadvantages of different methods for carbon calculation in Appendix C. In some cases, an additional carbon assessment using the Defra Emissions Factor Toolkit (EFT) is required. If this is the case, the results of this assessment should be reported on a separate line so that it can be compared with the TUBA assessment. Note that the EFT result should not be added into the total carbon emissions below to avoid double counting. The advice in Appendix C about the application of the EFT to the calculation of carbon emissions should be noted.

Any additional induced traffic calculation results using the methodology in the Stage 2 Guidance should also be reported separately here.

Care should be taken to ensure that it is possible to reconcile the carbon emissions reported here with the results in the greenhouse gases workbook. Where there are differences or omissions, these should be noted. The results in the greenhouse gases workbook should match the results reported in the Appraisal

Summary Table (AST) and the Analysis of Monetised Costs and Benefits (AMCB) Table in the economic case. This is to allow auditability of the carbon impact assessment process all the way through from the pro forma, via the greenhouse gases workbook, to the results reported in the economic case. Any variations between figures should be explained.

As with the rest of the pro forma, sufficient information should be provided to allow the calculations undertaken to be understood and linkages made between the carbon impact assessment and other information in the business case analyses.

4.6 Total carbon impact of the scheme

	Total carbon emissions (tCO2e)			
	Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
Total carbon emissions				
Carbon intensity (tCO2e per £m)				

The total carbon emissions of the scheme are simply the sum of the capital and operational carbon emissions over the relevant periods taken from the boxes in the previous sections. Note that if a separate EFT result is reported for a transport scheme, this should not be added in to avoid double counting.

For transport schemes carbon emissions from 'traded' and 'untraded' sectors should be reported separately, see TAG Unit A3. These should also be summed to produce a total carbon emissions figure.

The carbon intensity of the scheme is the total carbon emissions of the scheme divided by the scheme cost from the General Information section above. This should be given for the relevant periods identified with the same scheme cost used as the divisor in each case.

4.7 Notes

At the end of the pro forma is space for notes which might be relevant to the carbon emissions reported in the assessment.

These could include:

- Any significant sources of increased or reduced carbon emissions which have been omitted from the assessment
- Any shortcomings in the modelling of behavioural responses
- Any other possible impacts of the scheme mentioned in the rest of the business case which might have carbon implications, but which have not been included in the assessment. This could include possible developments 'unlocked' or facilitated by the scheme or otherwise dependent upon it.

Any note should include the likely implications in carbon terms, that is the effect in terms of increases or decreases in carbon emissions and, if possible, an indication of magnitude.

5. Auditability

The information provided in the pro forma and any additional information provided should be sufficient to allow proper scrutiny and audit of the process and to tie together the elements of the carbon impact assessment with the TAG greenhouse gases workbook and the results reported in the economic case in the Appraisal Summary Table (AST) and the Analysis of Monetised Costs and Benefits (AMCB) Table.

This should therefore include the TUBA output files and greenhouse gases workbooks relevant to the assessments. These should link through to the figures used in the AST and AMCB. If there are anomalies between the different sources of information, these should be identified and explained.

6. References

Design Manual for Road and Bridges, Sustainability & Environment Appraisal, LA 114 Climate, ver 0.0.1, June 2021

https://www.standardsforhighways.co.uk/dmrb/

Emissions Factors Toolkit (EFT), available from the Department for Environment and Rural Affairs (Defra)

https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit

The Green Book, Central Government guidance on Appraisal and Evaluation, HM Treasury, March 2022

https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

Guide to Developing the Project Business Case, HM Treasury and Welsh Government, 2018

https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

Latest evidence on induced travel demand: An evidence review, report for the DfT, WSP and Rand Europe, May 2018

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/762976/latest-evidence-on-induced-travel-demand-an-evidence-review.pdf

Tackling the Climate Emergency, Emission Reduction Pathways report, West Yorkshire Combined Authority and Leeds City Region Enterprise Partnership (LEP), July 2020

https://www.westyorks-ca.gov.uk/media/4268/emission-reduction-pathways-report.pdf

TAG Databook, Department for Transport, Transport Analysis Guidance (TAG), May 2022

https://www.gov.uk/government/publications/tag-data-book

TAG Unit A3 environmental impact appraisal, Department for Transport, Transport Analysis Guidance (TAG), May 2022

https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal

Transport User Benefits Appraisal (TUBA), software and user manuals

https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals

WYCA OBC and FBC Carbon Assessment Guidance, Methodologies for quantitative carbon analysis as part of the WYCA Assurance Process, report by Mott Macdonald (Stage 2 Guidance), January 2022

Appendix A Blank pro forma for a non-transport scheme

1. General Information

Name of scheme	As in PIMS
Type of scheme	Refer to the scheme typology in Stage 2 Guidance
Scheme opening year	
Appraisal period	The length of time over which the effect of the intervention is being assessed. Report the start date (which should match the opening year), end date (year) and number of years.
Brief description of the 'without scheme' case	What are we comparing this option for this scheme against? See note A
Brief description of the 'with scheme' case	What does this option for this scheme involve? See note A
Total scheme cost	Cost of this option for this scheme See note B

2. Background assumptions

Background assumptions	See note C

3. Capital carbon emissions

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
The sources of emissions included in the assessment (use multiple lines if necessary)	The method used for calculating the capital carbon (see Stage 2 Guidance)				

4. Modelling approach

Modelling approach	See note E

5. Operational carbon

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
The sources of emissions included in the assessment (use multiple lines if necessary)	The method used for calculating the operational carbon (see Stage 2 Guidance)				

6. Total carbon impact of the scheme

	Total carbon emissions (tCO2e)			
	Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
Total carbon emissions				
Carbon intensity (tCO2e per £m)				

7. Notes

See Section 4.7

Appendix B Blank pro forma for a transport scheme

1. General Information

Name of scheme	As in PIMS
Type of scheme	Refer to the scheme typology in Stage 2 Guidance
Scheme opening year	
Appraisal period	The length of time over which the effect of the intervention is being assessed. Report the start date (which should match the opening year), end date (year) and number of years. For a transport scheme the appraisal period is typically 60 years.
Brief description of the 'without scheme' case	What are we comparing this option for this scheme against? See note A
Brief description of the 'with scheme' case	What does this option for this scheme involve? See note A
Total scheme cost	Cost of this option for this scheme See note B

2. Background assumptions

Scenario	See note D
Background assumptions	See note D

3. Capital carbon emissions

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
The sources of emissions included in the assessment (use multiple lines if necessary)	The method used for calculating the capital carbon (see Stage 2 Guidance)				

4. Modelling approach

Modelling approach	See note E

5. Operational carbon

Scope/Source	**Carbon calculation methodology**	**Total carbon emissions (tCO2e)**			
		Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
See note F	See note G				

6. Total carbon impact of the scheme

	Total carbon emissions (tCO2e)			
	Up to end 2030	**Up to end 2038**	**Up to end 2050**	**Over whole appraisal period**
Total carbon emissions				
Carbon intensity (tCO2e per £m)				

7. Notes

See Section 4.7

Appendix C Calculating Carbon from Transport Schemes

B.1 Methodological comparison

Two main methods for calculating the carbon emissions from the outputs of a transport model are the use of the Transport User Benefits Appraisal (TUBA) software (or a similar calculation based on the information provided in the TAG Databook) and the Defra Emissions Factors Toolkit (EFT). Neither method is ideal, and both involve the use of estimations and approximations.

Neither TUBA nor EFT are referred to in the relevant section of the DMRB (LA 114). TAG Unit A3 refers to the TAG Databook, TUBA and also to the DMRB 11.3.1 air quality screening spreadsheet, but the latter now seems to have been withdrawn and is no longer available.

Each method uses information about the relationship between average speed and carbon emissions by vehicle type and year to estimate carbon emissions in both the 'with scheme' and 'without scheme' cases and therefore to calculate the change in carbon emissions from a transport intervention.

Ideally, each method should consider all time periods, all vehicle types and all parts of the network affected by the intervention. For a typical highway intervention, rerouting might have the effect of moving carbon emissions around, concentrating them in certain areas and reducing them over a wider area. It is therefore vital to consider all the affected parts of the network to avoid missing changes which may be individually small but widely dispersed and therefore large in total. The calculation of carbon emissions is different from the assessment of air quality problems where the focus may be on particular locations where there is a significant change in emissions which might breach air quality standards and/or sensitive receptor locations.

The following table gives an overview of the two calculation techniques.

	TUBA	**EFT**
Methodology	Averages both distance and speed for all trips between a given origin and destination. Uses the average speed and distance and the tables in the TAG Databook to calculate the carbon emissions on an origin to destination basis. All origin destination pairs need to be considered (carried out automatically by TUBA)	Averages the speed on a link basis, this is combined with the link length and flow to calculate carbon emissions on a link-by-link basis. All links affected by the intervention need to be considered.
Fleet mix (propulsion type)	The fleet mix (propulsion type) used by TUBA is as given in TAG Databook Table A1.3.9. This gives a forecast of the breakdown of propulsion type for each vehicle type.	2018-2030 Fleet and Euro Compositions (non-London) developed for NAEI (May 2019) 2031-2050 Default fleet assumptions in line with DfT/HE (2021) projections
Further details	DfT TAG Databook: https://www.gov.uk/government/publications/tag-data-book TUBA: https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals	https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit

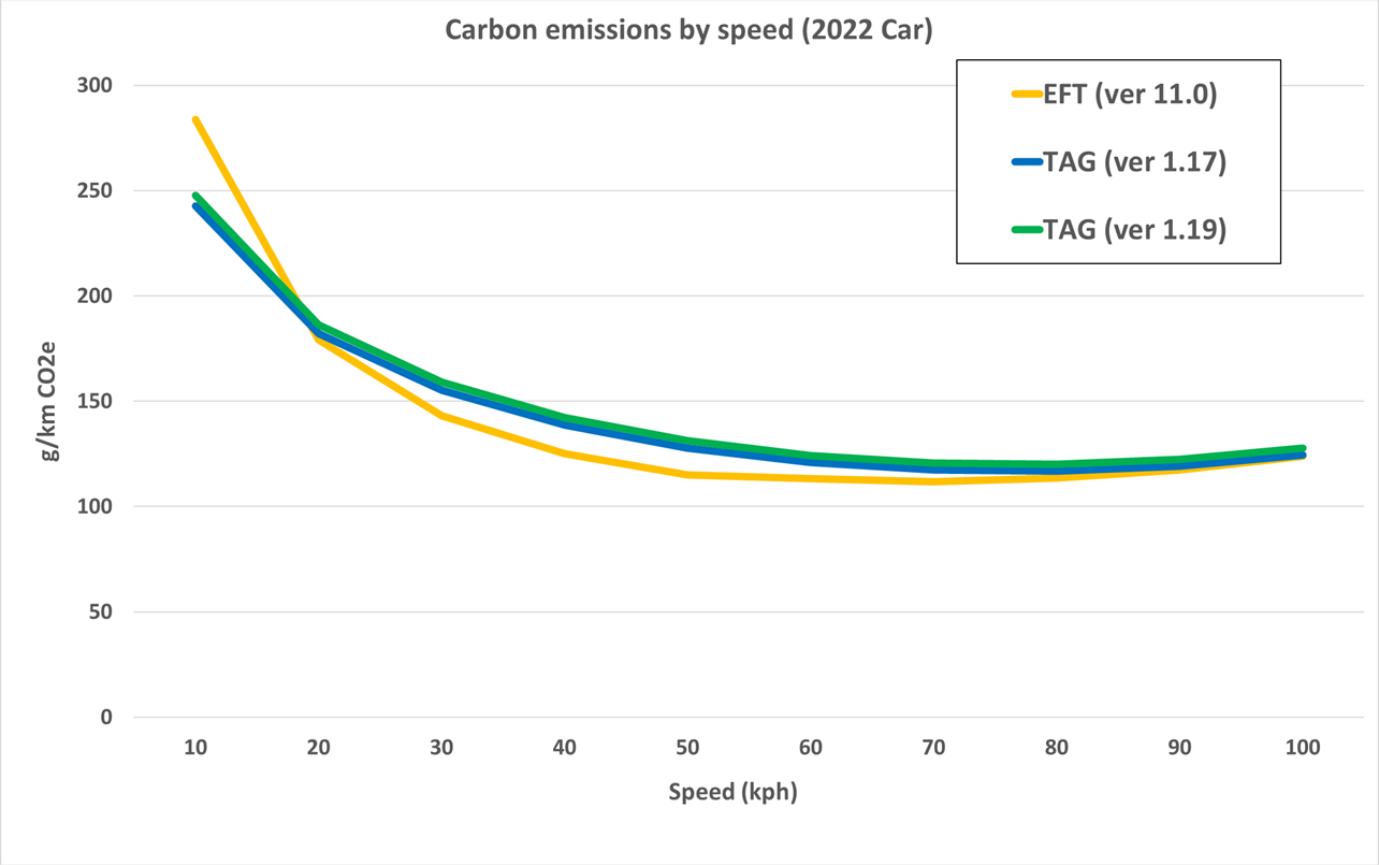
B.2 Discussion

Both methods involve averaging the speed of traffic, that is they represent a range of different vehicle behaviours by an average speed. This obviously introduces errors because of the nonlinear relationship between speed and carbon emissions (see Figure B.1 below). Overall, EFT is likely to be more accurate as it averages speed over a link rather than over an entire trip (or set of trips) in the case of TUBA. Even over a link, the actual profile of vehicle speed (and therefore emissions) is likely to be different from a steady

speed, typically involving acceleration, cruise and deceleration elements, each of which might have a very different emissions profile.

Figure B.2 shows how the emissions of a '2022 Car' (a representative mixture of the 2022 car propulsion types) vary with average speed for three different calculation methodologies. Note how average speed increases over the likely range of urban speeds (up 80 km/h or 50 mph) lead to decreases in carbon emission rates by distance. The line marked TAG (ver 1.17) shows the result of using the TAG Databook ver 1.17 (November 2021), TAG (ver 1.19) uses version 1.19 of the TAG Databook (forthcoming change) released in May 2022. The changes represented in TAG Databook version 1.19 have not yet been incorporated into TUBA at the time of writing (June 2022).

Figure B.1 – How carbon emissions vary by speed



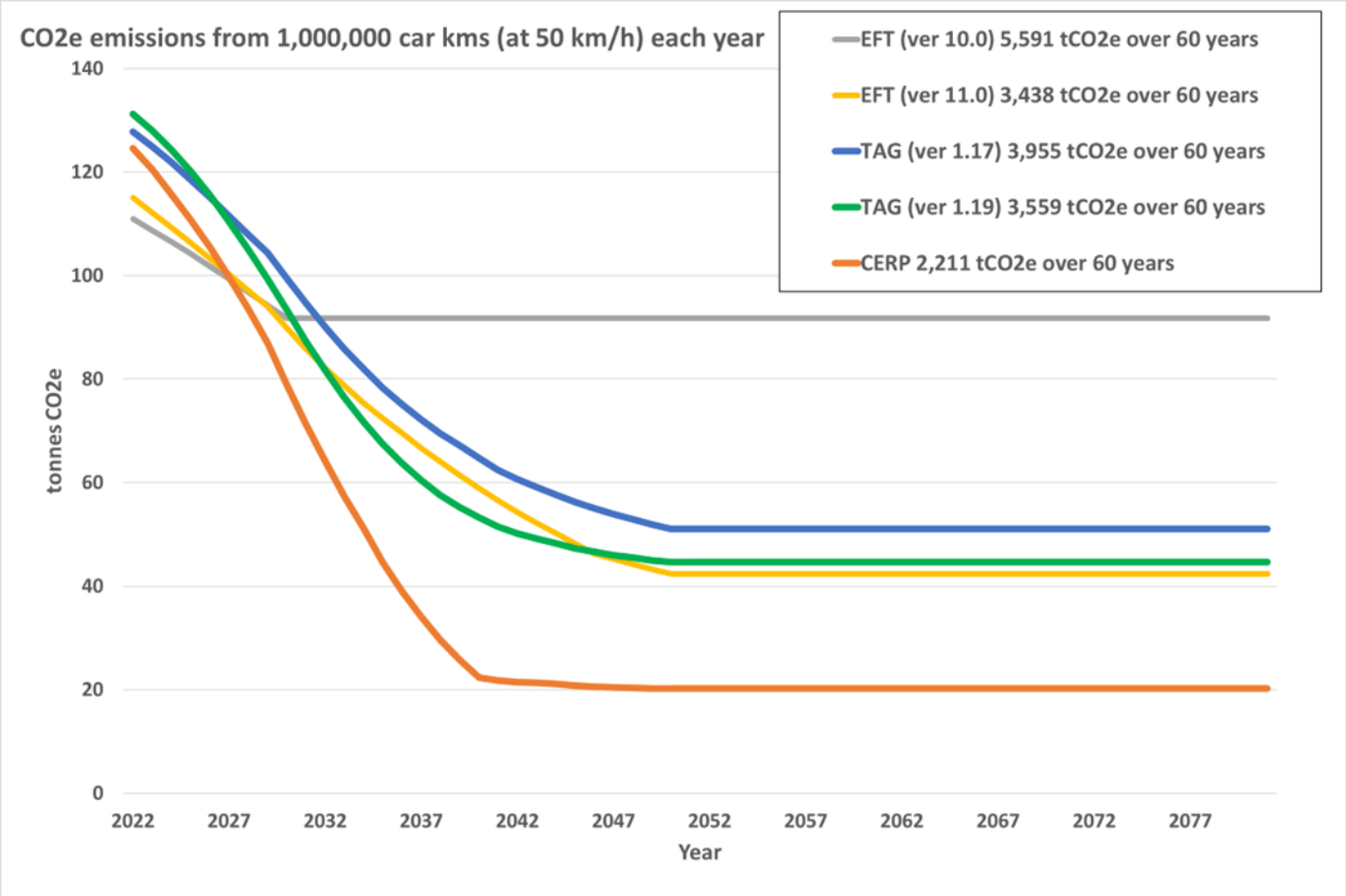
Both EFT and TAG methods also use forecasts of fleet mix – predictions about the future take up of different types of propulsion by vehicle type. Figure B.2 shows the difference that these forecasts make (by showing the carbon emissions from 1,000,000 'representative' car kms at 50km/h for each year into the future). The line marked TAG (ver 1.17) shows the result of using the fleet mix associated with the current version of TUBA; TAG (ver 1.19) incorporates recent changes to the fleet mix assumptions in version 1.19 of the TAG Databook (forthcoming change) released in May 2022. CERP is the fleet mix specified in the 'low carbon' scenario, which is more optimistic about the take-up of electric vehicles. The flat lines towards the right-hand side of the graphs show where the assumptions 'run out' and the same fleet mix has to be assumed for the remainder of the appraisal period. EFT version 10.0 only specifies fleet mix up to 2030, CERP to 2040 (the extent of the carbon emission reduction pathways model) while both TAG versions and EFT version 11.0 have fleet mix forecasts extending to 2050. Note that this means that the longer forecasts still cover less than half of a typical 60-year appraisal period.

Reassuringly, the most recent version of EFT and both TAG versions seem to use fleet mix assumptions which give (for car at least) relatively similar carbon emissions. The recent update to the fleet mix assumptions in TAG (ver. 1.19) makes a difference compared to the previous (ver 1.17) version but is still not as optimistic about the uptake of electric cars as the 'low carbon' (CERP) scenario. Overall different assumptions produce very different results and the lack of longevity of forecasts obviously distorts results for a typical 60-year appraisal period.

EFT (ver 11.0), both TAG versions and the 'low carbon' (CERP) scenario all use fleet mix forecasts which extend beyond 2038. This means that the operational carbon emissions estimates 'up to end 2030' and 'up to end 2038' are likely to be more reliable than those associated with dates further into the future.

The TAG (ver 1.17) fleet mix assumptions, as given in TAG Databook ver 1.17 Table A1.3.9 and currently used by TUBA, assume over 50% of car kilometres will still be done in petrol and diesel vehicles in 2050 and therefore might be regarded as pessimistic. TAG (ver 1.19), as given in TAG Databook ver 1.19 (forthcoming change) Table A1.3.9 assumes that 33% of car vehicle kilometres will be done in petrol and diesel vehicles in 2050.

Figure B.2 – How assumptions about fleet mix (propulsion type) affect carbon emissions



B.3 Using EFT

As noted above, a TUBA (or similar) approach should be used to carry out the carbon calculations reported in the carbon impact assessment pro forma (under operational carbon emissions). For schemes with a cost above £20m, promoters should (unless it can be justified otherwise) additionally undertake an analysis of the carbon emissions using the Defra Emissions Factor Toolkit (EFT).

Based on the discussion in this appendix, use of EFT should cover:

All of the links affected by the intervention This is so that relatively small, but potentially widespread changes in carbon emissions are not missed which could lead to systematic errors in carbon assessment. Note that this is different from the approach used in air quality assessment, where only links with a significant change in vehicle behaviour are assessed.

All modelled time periods separately Averaging vehicle behaviour (speed) to aggregate time periods or cover unmodelled time periods should not be done as this introduces errors. If the modelled periods do not cover the entire 8760 annual hours, the same approach should be used as for reporting TUBA results – the modelled time periods should be noted and where there is felt likely to be a difference between the carbon emissions from the 'with scheme' and 'without scheme' cases

outside these time periods this should also be noted, and any mitigation measures undertaken should be described.

All future years Up to the end of the appraisal period and capable of being reported in the ‘up to …’ dates requested on the pro forma.

For both the ’with scheme’ and ‘without scheme’ The difference between the two being the carbon impact of the intervention.

Any results from EFT should be reported in addition to the TUBA derived results.

At the moment, there does not seem to be a way of altering the fleet mix (propulsion) assumptions in EFT and therefore calculating the carbon emissions using the ‘low carbon’ scenario, which incorporates different assumptions about fleet mix, does not seem to be possible.