Low Emission Strategies Partnership

LET Method Summary

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LET Method Summary prepared by Green Sphere Limited on behalf of the LES Partnership.

Incorporating recommendations from a technical review undertaken by Aether and AQC.

Contents

1 Overview

1.1 Background

The LES Partnership

The Low Emission Strategies Partnership (LESP) is a group of local authorities working together to improve air quality and tackle climate change, by reducing emissions from road transport.

The LESP promotes ambitious joined up action to reduce both emissions of toxic air pollutants and greenhouse gases, delivered by cost effective and practical interventions supported by robust impact assessment.

The Partnership specialises in the development and use of emission based assessment to support policy and action. In doing so it also works widely to enable integration with complementary drivers, interventions and approaches. Further information is available online at: www.lowemissionstrategies.org

The Low Emission Toolkit

The LESP is working to develop methods, systems and tools to support the adoption of the LES approach by local authorities. Key to this is the Low Emission Toolkit (LET), an excel-based tool, to assess the costs and emissions benefits of low emission transport interventions.

The LET was developed to address a need for quantification to support an evidenced based approach in three specific areas identified by Local Authorities:

1. *Vehicle Technology Guidance:* Comparing different low emission vehicle technologies on costs and emissions, as well as other factors such as practicability and co-benefits.
2. *Low Emission Fleets:* Calculating emissions from existing managed transport fleets and assessing the costs and benefits of low emission replacement strategies.
3. *Low Emission Developments:* Calculating transport emissions associated with new developments and assessing the impacts of planning mitigation measures.

Funding was sourced through the Defra Air Quality Grant and via financial and in-kind contributions from partner local authorities. Development of the LET began in 2010, with version 1.0 launched in April 2011. Following user review and feedback, minor upgrades were subsequently commissioned, and version 1.1 was completed in January 2012.

1.2 This Document

Purpose

General information on the LET is available from the LESP website: This includes material that explains the purpose of the toolkit, and also a detailed instruction manual.

This document is aimed at policymakers, environmental managers and other users, who have some technical knowledge and are interested in understanding the underlying approach and functionality of the toolkit. It provides a summary of the methodology that is used by the LET (v1.1) in a single stand-alone document. The purpose is therefore to provide the technical reader with:

- A precise overview of what the tool is designed to do;
- Information on the underlying methodologies and data-flows that are used for the different Applications;
- A listing of the data that is used in the toolkit.

The low emissions technical area can be complex, and is evolving. On-going development and refinement of the toolkit, coupled with user feedback and testing is likely to result in changes that will need to be captured in future versions of this report.

Structure

The document is structured as follows:

Section 2 - Applications	A summary of the functions of the three LET Applications and their context in terms of the LESP approach to emissions based assessment.
Section 3 – Technology Guide (Application 1)	A description of the methodology employed by the LET, and the associated data flows and calculations.
Section 4 – Fleet Tool (Application 2)	A description of the methodology employed by the LET, and the associated data flows and calculations.
Section 5 – Development Tool (Application 3)	A description of the methodology employed by the LET, and the associated data flows and calculations.
Section 6 - Data Quality and Transparency	A summary of the main issues
Section 7 – Method Conventions And Constraints	A summary of the main issues
Section 8 – User Advice and Known Issues	A summary of the main issues
Appendix A – LET data sets	A list of the data sets
Appendix B – Key references	Key references for further reading

2 Applications

2.1 Overview of LET Applications

Application 1: Technology Guidance

This Application provides comparative information at an individual vehicle level for standard and low emission vehicles on the following criteria:

- Air quality pollutant: estimates of tank to wheel PM_{10} (both hot exhaust and brake/tyre wear) and NO_X emissions;
- Greenhouse gas emissions: estimates of well to wheel CO_2equivalent emissions;
- Financial costs: fuel infrastructure costs and operating and capital costs;
- Emissions damage costs: for PM_{10}, NO_X and CO_2e separately and also combined;
- Fuel efficiency;
- Qualitative information on: technological maturity, practicability and co-benefits of the alternative fuels and powertrains.

Application 2: Fleet Tool

This Application allows a user to calculate the emissions from a managed transport fleet and estimate the costs and emissions benefits of different replacement strategies with standard or low emission vehicles.

Application 2 includes a time component, reporting the results over a given number of years.

Application 3: Development Tool

Application 3 has been developed to support local authorities in implementing best practice guidance produced by the LESP and Defra in 2010: Low Emission Strategies – Using the Planning System to Reduce Road Transport Emissions[1]. The concept is depicted in Box 1, overleaf.

Application 3 allows a user to input basic data about a new development and derive an estimate of the transport emissions associated with it, without any measures being implemented.

The user can then select from a range of planning measures (included within the tool) and derive the potential emission benefits and associated costs.

The tool also estimates residual emissions (those emissions remaining after on-site measures have been applied, which would need to be tackled in order for a zero emission development to be obtained), and residual damage costs, which may be used to further inform negotiations with developers.

[1] Available online at: http://www.lowemissionstrategies.org/les_planning_guidance.html

Box 1: Low Emission Developments

Within the planning context, a Low Emission Strategy may be considered as a package of measures to help mitigate the impacts of a development. They may be secured through a combination of planning conditions and legal obligations (section 106 agreements), or via a Community Infrastructure Levy. They may incorporate policy measures and/or require financial contributions to the delivery of low emission transport projects and plans. Example measures include: emission based parking policies, investment in low emission infrastructure, fleet emission improvement, low emission procurement and supply chain initiatives and contributions to local transport projects.

There are three different types of measure (or "intervention") that can be used for reducing emissions from the transport sector:

- Avoid: Travel is reduced, resulting in less frequent or shorter journeys. An example would be the implementation of travel plans which incorporate home working.
- Shift: A shift is made to private to public transport or from motorised to non-motorised transport. An example would be providing a fast frequent bus service or the development of cycle paths.
- Improve: Improvements are made to the mode of transport with respect to emissions, typically through technological means (although not always). Examples include fleet improvement, low emission procurement, supply chain initiatives and driver training.

Some individual measures can result in complex impacts. For example, emissions based parking may act as a disincentive to travel (avoid), it may encourage the use of public transport (shift) and may even influence decisions associated with purchasing new private cars (improve).

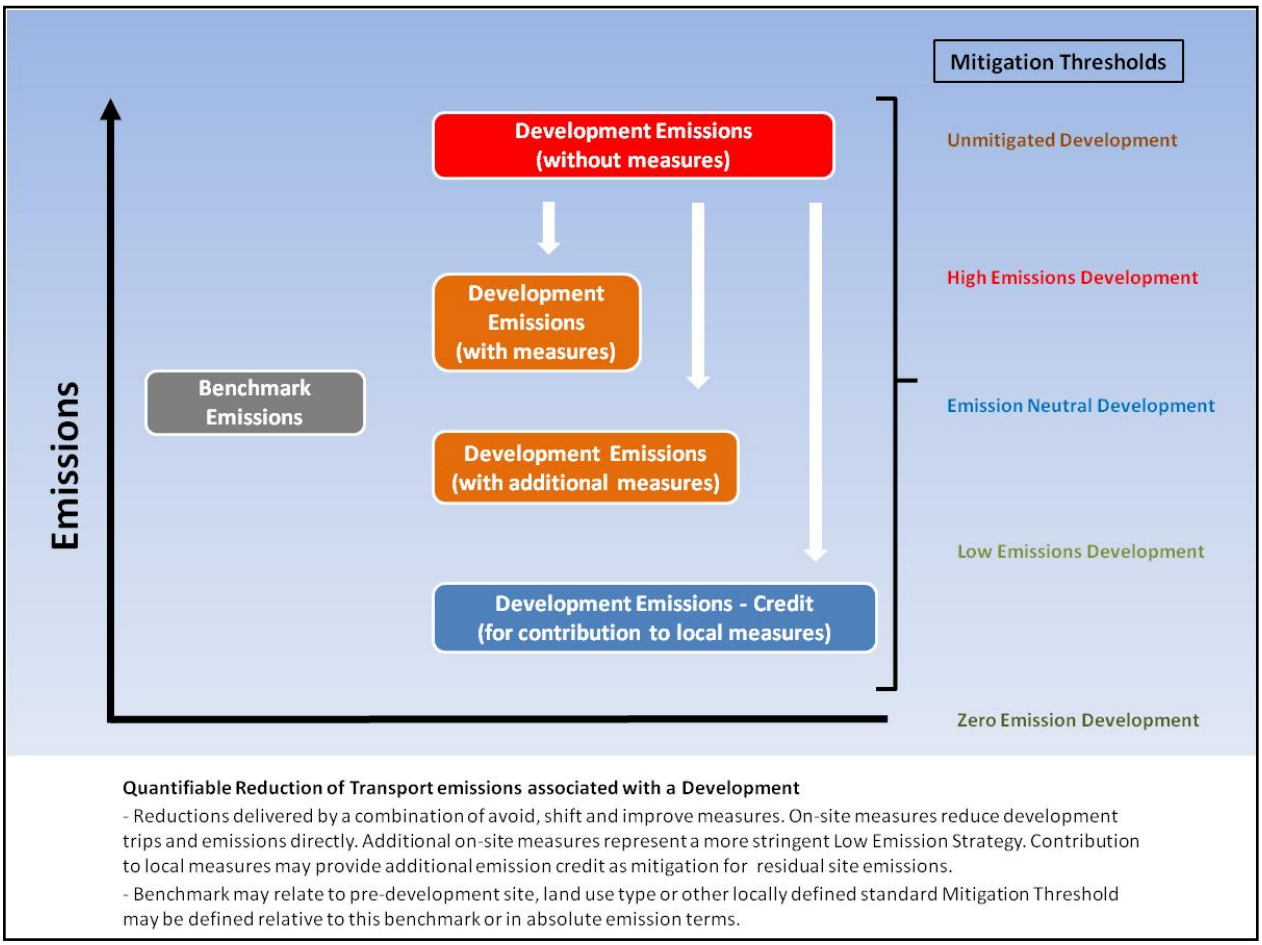
Individual measures are combined to give a package that constitutes a Low Emission Strategy.

Figure 1 shows how Low Emission Strategies drive down transport emissions to the lowest achievable level. Through this approach low (or near zero) transport emission developments become a viable objective.

A key strength of Low Emission Strategies is that they are based on tailored packages of measures to give the most effective overall impact. A strategy may be formed by any combination of avoid, shift and improve measures. However, this practical strength and versatility creates a technical challenge in terms of assessing and quantifying the resulting impacts however.

Application 3 of the LET addresses this problem, by assessing the impacts of the three intervention types directly within its assessment methodology. The toolkit also facilitates a fourth mode of emission reduction, namely offsetting of the remaining residual emissions.

Figure 1: Schematic of the LES approach to reducing transport emissions at development sites



2.2 LES Assessment Types

The LES Partnership has formulated a suite of "low emission assessments" (LEA 1-10) to provide a structure to formulating a low emissions approach. The three Applications in the LET 1.1 are designed to support six of the assessments (LEA 1-6), while the LESP National Assessment Report is itself an example of LEA 10. Table 1 below provides a summary of the relationship between the LET Applications and Low Emission Assessments.

The focus for immediate practical use of the LET is for LEA 3 (Fleet Management Plans) and LES 6 (Development Agreements). These are marked with red ticks in table 1.

In parallel, the LESP continues to develop LET functions and guidance in relation to the other assessments. It is also considering development of a fourth application, which would support the user in undertaking the more strategic level assessments (LEA 7-10) - for example across a whole authority area, or for all of the measures contained within an air quality action plan.

Table 1: Assessment types supported by the Low Emission Toolkit

Low Emission Assessment (LEA 1-10)	Description	App 1	App 2	App 3	'App' 4
1. Technology Comparisons	Compare one type of vehicle against another on emissions, costs and qualitative data	✓			
2. Vehicle Procurement Policies	Informing decisions on low emission vehicle procurement – either by comparing single vehicles, component or whole fleets	✓	✓		✓
3. Fleet Management Plans	**Reviewing current (baseline) emissions and modelling impacts of changes through low emission vehicle procurement**		✓		
4. Action Plans (Component Interventions)	Estimating emissions impacts of single measures or packages of measures applied across a given area through an Air Quality Action Plan	✓	✓	✓	✓
5. Planning Policy	Informing development of planning policy, including: (i) development management; (ii) strategic planning	✓	✓	✓	✓
6. Development Agreements	**Estimating emissions impacts of single measures or packages of measures applied at development sites to mitigate the effects of transport associated with the development.**			✓	
7. Area wide infrastructure / technology strategy	Estimate emissions impacts from uptake in low emission vehicles, following implementation of an area-wide infrastructure/technology strategy				✓
8. Area-based transport interventions (including LEZs)	Estimate emissions impacts following application of transport interventions across a specific area that result in reduce/ shift/ improve behaviour				✓
9. Action Plans (Total Impact)	Estimating emissions impacts of the full suite of measures applied across a given area, through an Air Quality Action Plan				✓
10. National/Regional Case	Strategic emissions assessment at regional or national level, for example presenting a high level 'case for action.'				✓

3 Technology Guide (Application 1)

3.1 Methodology Overview

Outline

The Technology Guide is the first building block in the tool. It is made up of detailed information on specific types of vehicles. It enables the user to select and compare standard and low emission vehicle technologies in various contexts. A summary of the output is available in a standalone PDF document.

Default factors

Application 1 (or App1) is based on default data contained within the toolkit for **Standard and Low Emission Vehicle Technologies** (refuelling infrastructure costs, capital and operating costs, fuel efficiency and NO_X/PM_{10} emission factors), **Fuel Factors** (well to wheel CO_2 equivalent emission factors[2]) and **Economic Factors** (fuel price, social damage costs, payback period, inflation rate). It also includes **qualitative** information on technological maturity, practicability and co-benefits for the low emission vehicle technologies.

User inputs

The user sets the scenario inputs, including the **year**, **predominant journey type** (urban / rural / motorway), annual **mileage** of the vehicle, together with information on the **geographic context** (type of town or city[3]). The user then selects one or more **vehicle types** from the range of standard and low emission vehicles listed within the tool[4].

Outputs

For each vehicle technology the tool calculates:

- Annual **Emissions** (well to wheel CO_2e[2], NO_X and PM_{10} hot running exhaust and brake/tyre wear);
- **Financial Costs** (capital and operating);
- **Social Damage Costs**;
- **Fuel Efficiency.**

Outputs are provided in tables as well as graphically. The results can also be exported to PDF outputs, enabling the user to print information sheets on different vehicle types.

[2] Estimates for natural gas, standard electricity and renewable electricity are currently provided in terms of CO_2 and not CO_2 equivalent. This will be revised and a consistent approach taken in subsequent revisions of the toolkit (see section 6.2).

[3] The user choices for **Type of town/city** are based on the National Travel Survey area types: Central London / Inner London / Outer London / Inner Conurbation / Outer Conurbation / Urban Big (>250,000 population) / Urban Large (>100,000 population) / Urban Medium (>25,000 population) / Urban Small (>10,000 population) / Rural.

[4] Standard Vehicle Technologies are a subset of the DfT vehicle classification scheme. Low Emission Vehicle Technologies include all combinations of fuel/drive trains for which prototype/pilot, demo/trials, limited scale production and/or mass scale exploitation are known. Combinations that do not exist or are not expected to exist (other than in Research or Proof of Concept form) by 2015 are excluded.

Figure 2 below provides an illustrative schematic of the technologies and vehicle types that are considered in this Application.

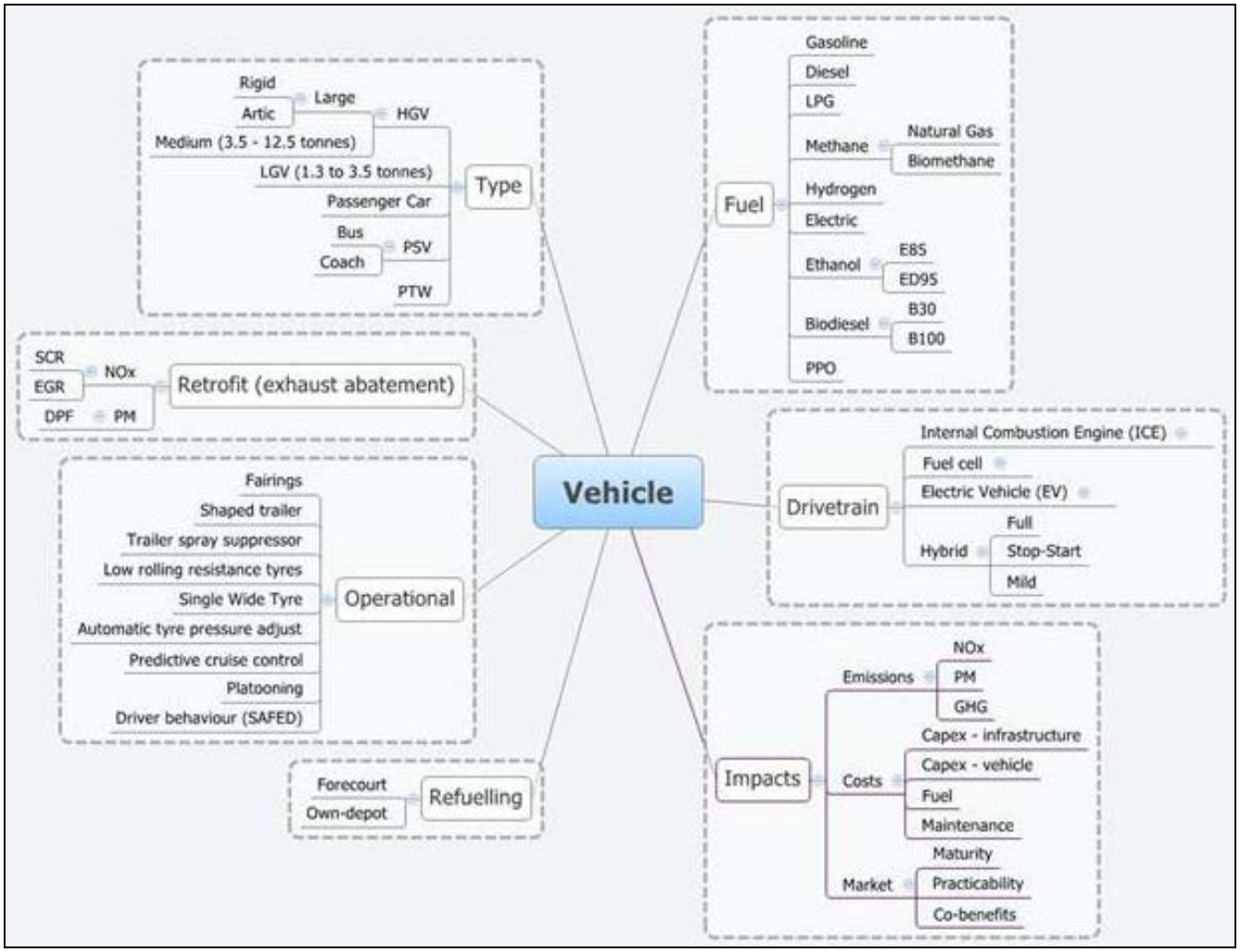
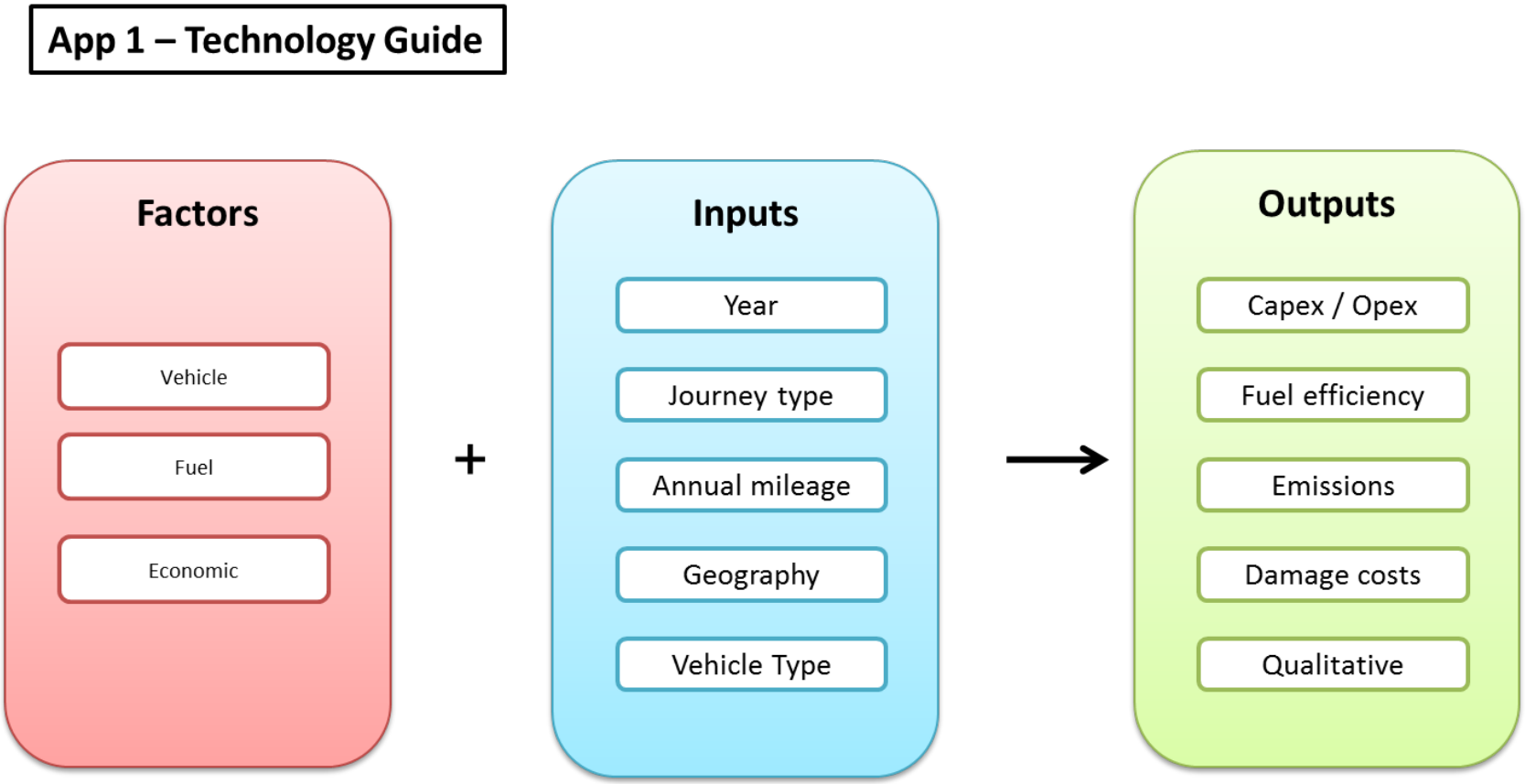


Figure 2: Vehicle technologies and features covered in the Toolkit and Vehicle Technology Guide (ref. LET User Guide)
Please note: This diagram is illustrative of LET Vehicle/Technology Types, however it does not map exactly (e.g. two wheeled vehicles and NO_X retrofit solutions are not included in LET). Please refer to the LET data tables for a precise specification.

3.2 Dataflows and Calculations



Application 1 – Technology Guide			
Factors	**Inputs**	**Outputs**	**Formulae**
Vehicle Factors **c** Capex (£) **o** Opex maintainance (£/vkm) **f** Fuel efficiency (l/vkm, kg/vkm or MJ/vkm) **en** NO_X vehicle emission factor (g/vkm) **ep** PM_{10} vehicle emission factor (g/vkm) **q** Technological maturity, practicability, co-benefits (Qualitative) **Fuel Factors** **e** Energy content (MJ/l or MJ/kg) **w** Well to wheel CO_2 (gCO_2e/MJ) **ec** CO_2e fuel emission factor (**e** x **w** gCO2e/l or /kg) **Economic Factors** **p** Fuel price (2010-25) (£/l or £/kg or £/MJ) **dc** Damage cost CO_2 (2010-25, £/kg) **dn** Damage cost NO_X (£/kg) **dp** Damage cost PM_{10} (by geography) (£/kg) **r** Payback period (years) **i** Inflation rate (%/y)	**Y** Year (2010-25) **J** Journey Type **M** Annual mileage (km) **G** Geography **V** Vehicle Type	**CV** Capex Vehicles (£) **OM** Opex maintenance (£)[5] **OF** Opex fuel **FE** Fuel efficiency (L/kg/ MJ per vkm) **EC** CO_2 emissions (kg) **EN** NO_X emissions (kg) **EP** PM_{10} emissions (kg) **DC** Damage cost CO_2 (£) **DN** Damage cost NO_X (£) **DP** Damage cost PM_{10} (£)	**CV** = **c** / **r** **OM** = **M** x **o** **OF** = **M** x **f** x **p** **FE** = **f** **EC** = **M** x **ec** / **1000** **EN** = **M** x **en** / **1000** **EP** = **M** x **ep** / **1000** **DC** = **EC** x **dc** (but see below) **DN** = **EN** x **dn** (but see below) **DP** = **EP** x **dp** (but see below) **Dependencies** Emission Factors are dependent on Journey Type and Vehicle type Fuel efficiency is adjusted by operational aspect factors, if specified Fuel price is year dependent. All damage costs are adjusted for inflation and calculated as present value to base year PM damage costs are Geography dependent

[5] Note there is a typo in the LET. The units are labelled as £/vkm, but should be £/yr

4 Fleet Tool (Application 2)

4.1 Methodology Overview

Outline

The Fleet Tool (Application 2 or App2) enables the user to describe a **Base Fleet**; to define a **Fleet Low Emission Strategy** and to assess the associated **Emissions**, **Financial Costs** and **Social Damage Costs.**

It draws on the **Technology Options, Emission Factors** and **Cost Data** presented in Application 1 (see Figure 2 above). It also allows the user to select from a range of **Operational Aspects**[6]**.**

The Application is designed primarily for use with **managed or captive fleets** (for example Local Authority service vehicles), where the input data required is most likely to already exist. For situations where the fleets are not owned or managed centrally, input data for Application 2 are likely to be harder to compile. In these situations, Application 3 is likely to be more appropriate.

Scenario Inputs

The user sets the scenario inputs, including the **start and end year**, predominant **journey type**, and **geographic context**.

Base Fleet

The user then constructs the 'base fleet' by creating one row per **Fleet Component**, and inputting the number of vehicles and the annual mileage for each row. The tool calculates the base fleet emission estimates (GHG, NO_X, PM_{10}), financial and social costs as for Application 1. These are then summed across all vehicles to provide results for the whole fleet.

The user may also define their own 'custom vehicle(s)', which can be saved to the toolkit for use across Applications 2 and 3.

Fleet Low Emission Strategy

The user can explore fleet replacement and management scenarios (i.e. a low emission strategy for the fleet), by using any of the fuel/vehicle technologies contained within the toolkit. The tool projects year on year changes to a specified end date.

To define a Fleet Low Emission Strategy the user specifies both a **Replacement Vehicle Type** and **Replacement Criteria** for each fleet component. The vehicle type is defined in the same way as for the original vehicles. Replacement criteria can be defined in the following ways:

- Number (or percentage) of vehicles replaced each year;
- Replacement at a specified age;
- Specified number of replacement vehicles introduced each year;
- Annual Mileage changes of the original and replacement vehicles each year.

[6] The user can confirm presence of the following Operational Aspects (where relevant to the vehicle): fairings, shaped trailer, trailer spray suppressor, low rolling resistance tyres, single wide tyre, auto tyre pressure adjust, predictive cruise control, platooning, driver behaviour (SAFED). These selections activate associated adjustments to fuel efficiency factors – default adjustments are included in the toolkit, which can also be edited by the user.

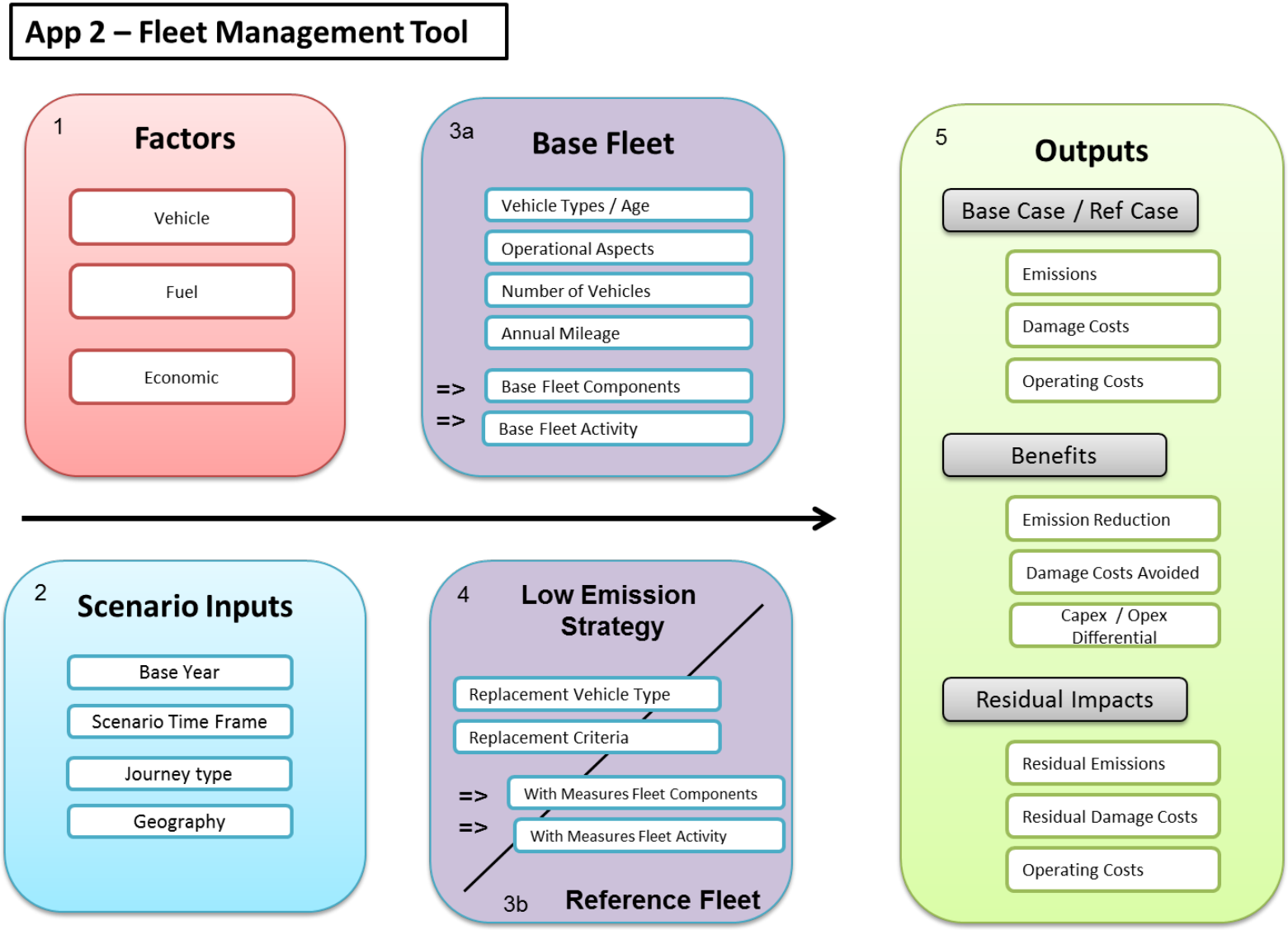
Outputs

The tool calculates **Emissions**, **Financial Costs** and **Social Damage Costs** for each year of the Low Emission Strategy. The outputs are presented in the form of custom graphs and tables.

Outputs from different scenarios that represent the base case, emissions with measures, emissions with additional measures etc. can be compared to obtain an understanding of the sensitivities between emissions reduction, financial costs, social damage costs etc.

This provides evidence based scenario analysis that is very helpful in underpinning policy.

4.2 Dataflows and Calculations



Application 2 – Fleet Management Tool

Factors	Inputs & Definition of Fleets	Outputs	Formulae
Vehicle Factors **l** Capex Infrastructure (£) **c** Capex Vehicle (£) **o** Opex maintenance (£/vkm) **f** Fuel efficiency (l/vkm, kg/vkm or MJ/vkm) **en** NO_X vehicle emission factor (g/vkm) **ep** PM_{10} vehicle emission factor (g/vkm) **Fuel Factors** **e** Energy content (MJ/l or MJ/kg) **w** Well to wheel CO_2 (gCO_2e/MJ) **ec** CO_2e fuel emission factor (**e** x **w** gCO_2e/l or /kg) **Economic Factors** **P** Fuel price (2010-25) (£/l or £/kg or £/MJ) **dc** Damage cost CO_2 (2010-25, £/kg) **dn** Damage cost NO_X (£/kg) **dp** Damage cost PM_{10} (by geography) (£/kg) **r** Payback period (years) **i** Inflation rate (%/y)	**Scenario Inputs** **YB** Base Year (2010-25) **YF** Final Year (2010-25) **J** Predominant Journey Type (urban, rural, m'way) **G** Geography **Base Fleet (BF_B, BM)** Comprising i components (B = b1, b2, …bi), each described by: **BV_B** Vehicle Type **BR_B** Reg Year or Euro Class **BO_B** Operational Aspects **BN_B** Number of vehicles **BM_B** Annual Mileage (km) **=> BF_B** Base Fleet Matrix **=> BM** Base Fleet Mileage **Low Emission Strategy ($S_{M,Y}$)** Comprising M measures (m_1,m_2…m_i) – 1 for each base fleet component - implemented over Y years (y1,y2..yf) LES (**$S_{M,Y}$**) is parameterised as: **RV_M** Replacement Vehicle (fixed over y's) **$RC_{M,Y}$** Replacement Criteria (by yr) And is applied to the baseline to create: => **$WF_{B,Y}$** With Measures Fleet (by yr) **Reference Fleet** Provides year on year reference point for calculating the Difference Fleet – See Section 6 **=> $RF_{B,Y}$** Reference Fleet (by yr) **Difference Fleet ($DF_{B,Y}$)** => **$DF_{B,Y}$** = **$WF_{B,Y}$** - **$RF_{B,Y}$** Difference Fleet (by yr)	**Core Outputs (10)** **CI** Capex Infrastructure (£) **CV** Capex Vehicles (£) **OM** Opex maintenance (£) **OF** Opex fuel (£) **FE** Fuel efficiency (various) **EC** CO_2 emissions (kg) **EN** NO_X emissions (kg) **EP** PM_{10} emissions (kg) **DC** Damage cost CO_2 (£) **DN** Damage cost NO_X (£) **DP** Damage cost PM_{10} (£) **DT** Total Combined Damage (£) **Fleet Prefixes** B Base Fleet (base year only) R Reference Fleet (by yr) W With Measures Fleet (by yr) D Difference Fleet (by yr) Note: combining fleet prefixes with output codes allows easy reference to the associated range of App 3 outputs.	CI = I / r CV = N x c OM = M x o OF = M x f x p FE = f EC = M x ec / 1000 EN = M x en / 1000 EP = M x ep / 1000 DC = EC x dc DN = EN x dn DP = EP x dp DT = DC + DN + DP **Dependencies** Emission Factors are dependent on Journey Type and Vehicle Type Fuel efficiency is adjusted by operational aspect factors, if specified Fuel price is year dependent. All damage costs are adjusted for inflation and calculated as present value to base year PM damage costs are Geography dependent.

5 Development Tool (Application 3)

5.1 Methodology Overview

Outline

Application 3 (or App3) operates on the premise that any development has a 'spatially derived fleet' that can be associated with it (i.e. **the Development's Transport Footprint**). This includes vehicles that are based at the site (**Origin Trips** - e.g. residents' vehicles, company fleets), as well as vehicles visiting the site (**Destination Trips** - e.g. goods and service deliveries, employees, shoppers).

It would be difficult to define a 'development fleet' in the same way as for Application 2 (individually identifying different elements in detail line by line). So Application 3 provides a "top-down" approach, which assigns fractions of the total fleet to different classes and technologies. This is flexible enough to make the best use of available data.

A second key difference between Applications 2 and 3, is that Application 3 works on a 'snapshot in time' rather than by projecting scenarios year by year into the future.

In other respects Application 3 functions in a similar way to Application 2. Once the base fleet and low emission measures have been defined, analogous outputs are calculated and presented.

Scenario Inputs

The user sets the scenario inputs, including the **year**, predominant **journey type**, and **geographic context** (as for Applications 1 and 2).

There is also an option to define multiple **'Development Components'**, which allow tailored resolution of the base fleet and better targeting of Low Emission Measures to specific aspects of the development. For example, for a mixed use development, different components could be defined for each land use. Similarly, for a multi-phase development it may be convenient to model different phases as separate components.

Base Fleet

The base fleet is built up by estimation of a vehicle fleet for each development component, which in turn is built up from individual estimates of passenger cars, buses and goods/service vehicles respectively (Figure 3).

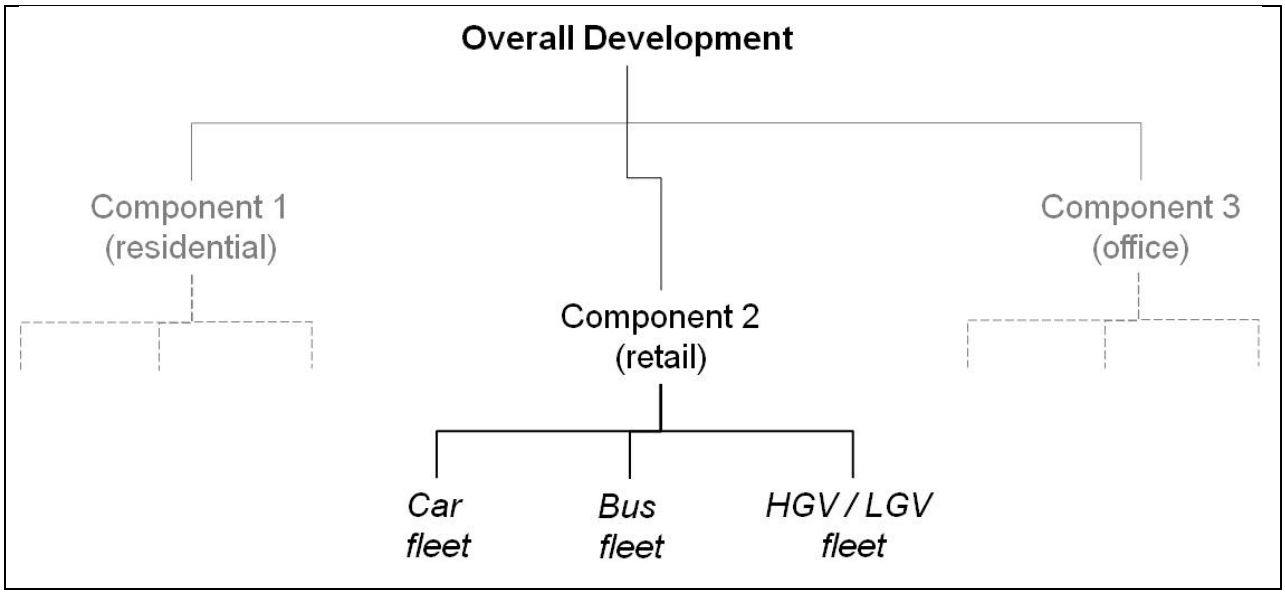


Figure 3: Development components

The tool enables estimates of total activity to be created in different ways, ranging from use of relatively crude defaults based on development size, type and location to more refined estimates based on detailed site specific data (e.g. data derived from transport assessments). These methods are summarised in Figure 4 below.

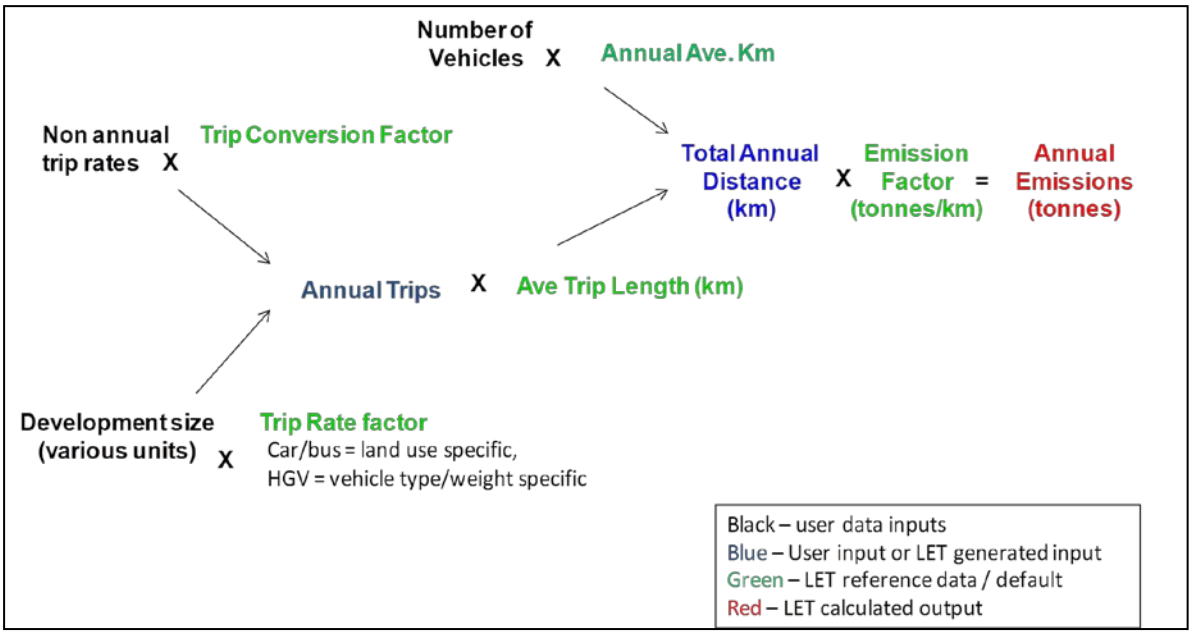


Figure 4: Estimation Methods for total Development Fleet Activity.

The toolkit input options vary depending on land use type and category of vehicle (see the LET Trip data tables for further information and flow diagrams).

The tool also uses information on typical UK fleet, with regional variations, to derive detailed compositions, thereby "drilling down" beyond the three broad transport categories (cars, buses and HGV/LGV).

Once established, the Base Development Fleet can be viewed in exactly the same way as in Application 2 (i.e. line-by-line, vehicle numbers and distance travelled by each type of standard and low emission vehicle technology). At this stage the user may also make direct modifications to the fleet table, for example to reflect specific local knowledge.

This approach provides an efficient way of constructing a base fleet, whilst still retaining the possibility for the user to tailor the detail according to the local data/knowledge that is available.

Base Fleet Outputs

Once the Base Development Fleet is defined, the tool calculates the **emissions** and related **damage costs** for the development in the same way as in Application 2. Outputs are generated in the form of tables and customisable graphs, and presented for the development overall, or by component.

Establishing this baseline is informative in itself. It provides an indication of the overall impact of the fleet or development in question. It also gives a sense of the general scale of the opportunity for emission reduction (particularly where the user has past experience or contextual guidance to draw on).

Low Emission Strategy and Associated Fleet Impacts

Having established the baseline, the user can then define mitigation **Measures** to be applied at the development site and explore the potential **Costs** and **Benefits**. It is possible to apply multiple and independently tailored measures for each Development Component. In combination, packages of such measures are termed a Planning Based **Low Emission Strategy.**

At the input stage, each measure can be tailored according to its intended use. Once defined, the tool translates each measure into one or a combination of discrete **Measure impact factors**: Avoid (reduction in trips/distance), Shift (to less polluting mode) and Improve (emission performance of vehicle), as introduced in Box 1.

These measure impact factors are the numerical basis by which the tool 'applies' Low Emission Measures and Strategies to the Base Development Fleet, thereby estimating the Overall **Fleet Impact** of the Low Emission Strategy. Impact Factors and overall Fleet Impacts can be viewed from the tool. The impact factors can be user- edited, for example, to reflect additional evidence or local information. (Note: The tool assumes that all impacts are additive, and therefore it is important that this is taken into account in terms of how measures are defined and in reality checking the underlying impact/effectiveness assumptions).

Table 2 illustrates the measures contained within the tool. The adopted structure reflects that described in the LESP/Defra Planning Guidance[7]. The table also indicates the assumed principal

[7] LESP/Defra (2010) Low Emission Strategies – Using the Planning System to Reduce Road Transport Emissions. Available online at: http://www.lowemissionstrategies.org/les_planning_guidance.html

avoid/shift/improve 'ASI' modes of action for each measure and indicates the user options for tailoring them. The Travel Plan measure draws on a table of sub-components, which are presented in Table 3.

NOTE: It is important to recognise the difference between a measure impact factor and a fleet impact.

A measure impact factor is the % of activity reduced or shifted or the % emission reduction from improved technology associated with the planning measure. A **fleet impact** is related to a measure impact factor, but is the factor applied to specific line in the target fleet.

So, for Avoid measures, impact factors simply reduce the mileage of the impacted fleet component(s). Impact factors used in Shift measures translate as a reduction in mileage for the impacted component(s), and at the same time an increase in the mileage for the component(s) that the mileage has been shifted to. Impact factors in Improve measures are used in the same way as Shift measures, except that they act on different technologies within a mode, rather than different modes.

Table 2: LET planning measures and their principal impacts

MEASURE		A	S	I	Tool functions (user selections)
Vehicle Substitution: Replacement with lower emission vehicles by fleet operators. High levels of effectiveness as impact on managed fleet.	Fleet/Pool Cars			Y	Select Euro class to be substituted Select fleet components to which the measure applies Determine % or absolute number to be substituted Select replacement (identify what happens to trips)
	Service Fleet			Y	
	Public transport fleet			Y	
Fleet Transformation: Transform the vehicle fleet by eliminating certain vehicles and replacing with lower emission alternatives. Effectiveness depends on the implementation mechanism and standards.	Site based-LEZ			Y	Select Euro class to be targeted Select fleet components to which the measure applies Determine % or absolute number to be substituted Select replacement (identify what happens to trips)
	Emission based parking			Y	
Low Emission Infrastructure: Provision for low emission infrastructure (note: the measure itself will not lead to an automatic fleet improvement).	Electric charging points			Y	Select infrastructure type and capacity [Note: including infrastructure affects the costs of measures only. The LET currently does not assume any impact on emissions.]
	Biomethane infrastructure			Y	
Car Clubs: Impact on distance travelled by car by its members (and emissions produced by cars used). Effectiveness depends on implementation and external factors. Proxy estimate is included in the LET of a 50% reduction in car vkm travelled by members, compared with non-members.	Standard Car Club	Y	Y		Specify % reduction of car kms by car club members (suggested default of 50%) Specify number of vehicles in car club Specify number of car club members (Specify type of low emission vehicle) Identify % shift to buses (and load factor)
	Low Emission Car Club	Y	Y	Y	
Travel Plans	Multiple interventions	Y	Y		[See Table 3 below]
User-based Charging: Economic incentives to encourage reduction in distance travelled, shift to public transport and improvement in emissions for particular vehicles. Effectiveness is highly dependent on implementation and external factors.	Congestion Charging	Y	Y		Identify % reduction in total distance travelled Identify % shift to buses (and load factor)
	E based parking charges	Y	Y	Y	Identify % reduction in total distance travelled (Identify number of car parking spaces removed) Identify % shift to buses (and load factor) Select Euro class to be targeted
	E based user charging	Y	Y	Y	Select fleet components to which the measure applies Determine % or absolute number to be substituted Select replacement (identify what happens to trips)

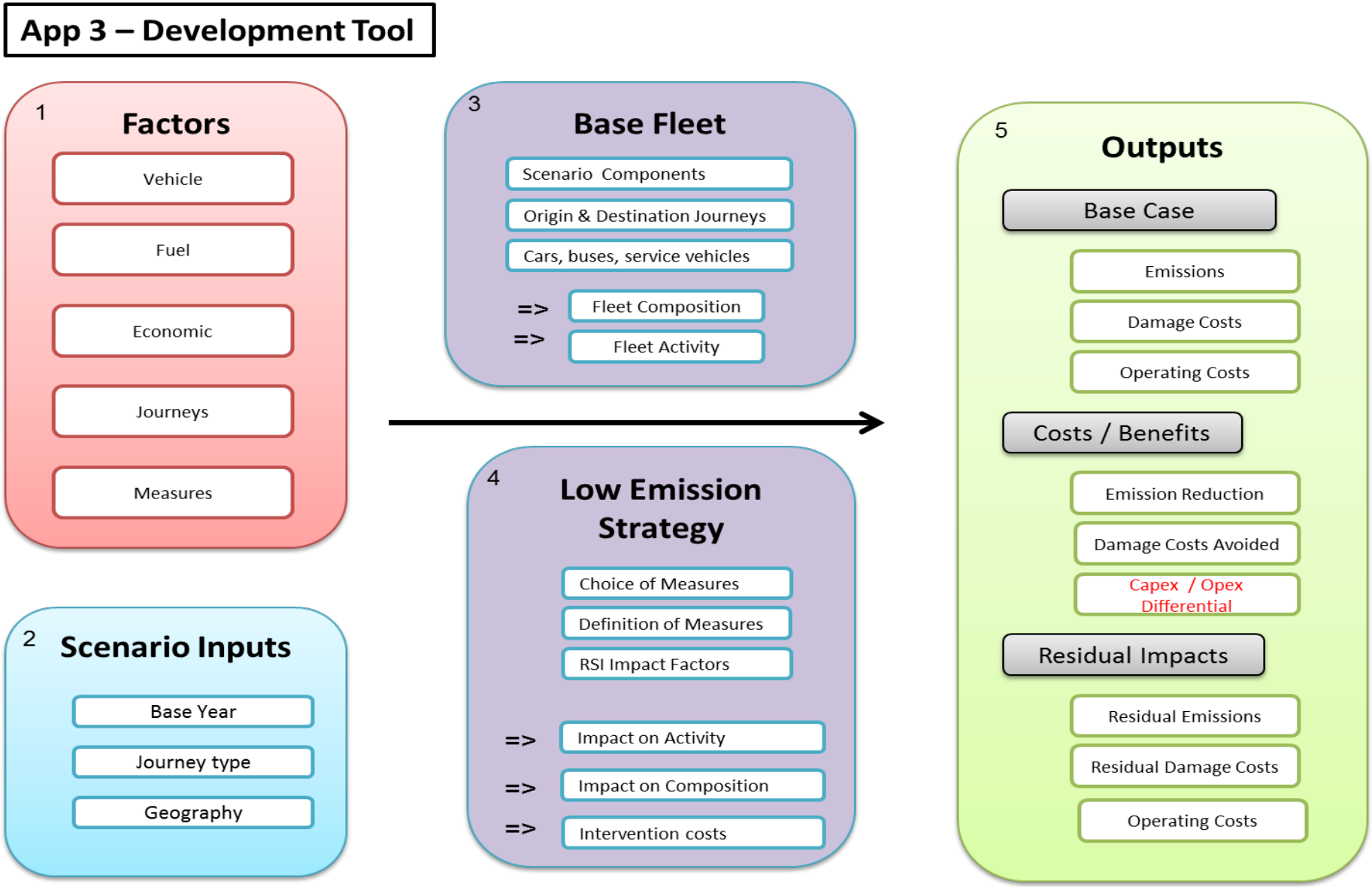
Table 3: LET travel plan measures and their impacts

#	Travel Plan Element	Mode of Operation			Tool functions (user selections)
		A	S	I	
1	Parking measures		Y		Identify total number employees/ residents Identify presence of: travel plan coordinator, promotion, monitoring, remedial measures Identify % drivers targeted by measure Identify specific factors for measure (defined within tool)
2	Car sharing schemes	Y			
3	Public Transport Measures		Y		
4	Walking		Y		
5	Cycling		Y		
6	Local recruitment	Y			
7	Relocation packages	Y			
8	Home working	Y			
9	Personalised Travel Planning	Y	Y		
10	Promotion	Y	Y		
11	Travel Awareness	Y	Y		
12	Video-, Tele-Conferencing	Y			

Costs, Benefits and the With Measures Fleet

The tool applies the estimated impact factors to the Base Development Fleet and so calculates **Emission Benefits**, **Damage Costs Avoided** and **Implementation Costs** of the Low Emission Strategy. By subtracting these from the Base Output Data, the tool also provides the **Residual Emissions** and the **Residual Damage Costs** associated with the **'With Measures' Development.** All results are provided for the development overall, by development component and can also be broken down by A,S,I measures.

5.2 Dataflows and Calculations



Application 3 – Development Tool

Factors / Options / Measures

Vehicle, Fuel, Economic All as for App2 plus…

cm Cost of planning measures (capex/opex)

Journeys

fc	Flow Conversion
tr	Trip Rates
tl	Trip Lengths
bl	Bus loading
sva	Service Vehicle Allocation

Measures

mt	Measures typology:
im	RSI impact modes table
tpe	Travel plan elements
tpi	Travel plan impacts
com	Costs of measures

App 3 (Development Tool) Estimation Methods

TM methods	Estimation of Fleet Mileage
FC methods	Estimation of Fleet Composition

App 3 (Development Tool) Notation and Principles

Base Fleet (BF) is notated as for App 2.

App 3 LES (S_M) comprises multiple measures ($S_{m1, m2, m3...}$), with corresponding impact factors for each.

Impact factors allow the LES to be 'applied' to the Base Fleet, creating the Difference Fleet and thereby the With Measures Fleet.

App 3 aggregates outputs by measure, development component and RSI impact mode. It does not calculate outputs at fleet component level.

Unlike App 2, the W/D Outputs are single year snapshots rather than projections over a number of years.

Inputs & Definitions

Scenario Inputs

Y	Base Year (2010 -25)
J	Journey Type (urban, rural, m'way)
G	Geography
D	Development Components (d1, d2, d3…)

Base Dev. Fleet (BM, BC_B => BF_B)

Estimated using App 3 est. methods:

=> BM Base Fleet Mileage (km)

=> BC_B Base Fleet Composition

=> BF_B Base Fleet

LES (S_M) and Difference Fleet (D_B)

LES (S_M) comprises M measures, toolkit defaults and user inputs allow tool to estimate impact parameters for each and in combination:

=> SR_B Direct Reduce (km)

=> SS_B Shift Increase (km)

=> SF_B Improve Increase (km)

=> DF_B Difference Fleet

(see note on p19 that explains how a Fleet Impact is established from Measure Impact Factors)

With Measures Fleet (W_B)

With measures fleet is then calculated from the Base and Difference Fleets:

=> $WF_B = BF_B - DF_B$

Outputs

Outputs

CM	Cost of Measures(£)
CI	Capex Infrastructure (£)
CV	Capex vehicles (£)
OM	Opex maintenance (£)
OF	Opex fuel (£)
FE	Fuel efficiency (various units)
EC	CO_2 emissions (kg)
EN	NO_X emissions (kg)
EP	PM_{10} emissions (kg)
DC	Damage cost CO_2 (£)
DN	Damage cost NO_X (£)
DP	Damage cost PM_{10} (£)
DT	Damage Cost Total (£)

Fleet Prefixes

B	Base Fleet
R	Reference Fleet
W	With Measures Fleet
D	Difference Fleet

Note: combining fleet prefixes with output codes allows easy reference to the associated range of App 2 outputs.

Formulae

CM = cm

CI = I / r

CV = N x c

OM = M x o

OF = M x f x p

FE = f

$EC_B = M_B$ x ec / 1000

$EN_B = M_B$ x en / 1000

$EP_B = M_B$ x ep / 1000

DC = EC x dc

DN = EN x dn

DP = EP x dp

DT = DC + DN + DP

Note: All damage costs are adjusted for inflation and calculated as present value to base year.

6 Data Quality and Transparency

6.1 Data Sources and Reference Data Sets

The LET uses a wealth of data from different sources to be able to provide quantified emissions reductions, costs and benefit information from the implementation of a variety of different measures. Key sources and references are summarised below:

- The **fleet composition data** and the raw **emission factors** for standard vehicles used within the LET 1.1 are consistent with the Defra Emission Factor Toolkit[8].
- The LET provides a unique **cost data** set, which can be referenced by the short title as '*Cost Data, Let 1.1'.* These data have been compiled from a range of published data for technology and infrastructure costs. Detailed sources and derivation are described in the LET Stage 2 Final Report, Version 1.1, Final, January 2011.
- The LET provides a bespoke data set to support generation of **trip and activity estimates,** which can be referenced by the short title: '*Trip Factors, LET 1.1*. These data have been compiled and derived largely from TRICS and TRAVL databases. They also reflect additional assumptions and the use of expert judgement. The derivation is described in: Annual Default Trips Generation Rates, RPS, August 2010.
- The LET provides a bespoke data set to support estimation of the **impact of low emission planning measures**, which can be referenced by the short title: '*Planning Measures Impacts, LET 1.1*'. This data has been obtained from a comprehensive review of reported case studies that have assessed the impact of various measures.
- The **Damage costs** applied within the LET 1.1 are consistent with those provided by the IGCB[9] and as described in the LET Stage 2 Final Report. See also notes in section 6.2 regarding the use of damage costs.

6.2. Data Quality

In the majority of cases, the LET data is based on well referenced datasets and from reliable sources. However, specific care and attention should be given to the following aspects:

Data Issues: Some of the default and underlying datasets are not as well characterised as others. A list of known data issues and uncertainties is provided in section 8.3. It is important that the user takes responsibility for considering the implication of these issues both on the results obtained by using the tool, and how they are used and presented.

Data for standard fuels and vehicles:

Whilst the LET uses the same raw emission factors for standard vehicles as that contained in the Defra emission factor toolkit, the LET differs in that it does not incorporate mileage degradation and fuel improvement factors. This will be addressed in subsequent updates to the LET.

[8] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

[9] http://www.defra.gov.uk/environment/quality/air/air-quality/economic/damage/

The CO_2e emission factors are in need of improvement and this will be conducted in subsequent updates to the LET. This is because there is some uncertainty over whether the factors do all represent CO_2e or are actually only CO_2 in some cases.

The capital cost data utilised in the toolkit does not currently take into account depreciation rates or the resale value and therefore care should be taken when using this data. In addition, the maintenance costs do not currently include the cost of insuring the vehicle. All of these costs will be reviewed in subsequent improvements to the LET.

Data for New Fuels and Vehicles

Cost and emission data for vehicle technologies, which are still new or yet to gain significant market penetration inevitably requires assumptions and data will not be as certain as for more established technologies. It is important that results are reported carefully and with appropriate levels of certainty (including reference to latest data update and data quality information).

The CO_2e factor provided for renewable electricity is in need of updating. With regard to the reporting of renewable electricity, the Defra GHG guidelines suggest that even when purchasing a green tariff that the national grid factor should still be used, unless additionality can be shown. This approach will be followed in subsequent updates of the LET.

Planning Measures: Further work is required to provide more information on the likely impacts of different planning measures. At present the data collected have been limited due to a lack of comprehensive information being available. As the number of low emission measures implemented increase, more data will become obtainable on the impact that different measures have. This is a current shortfall of the tool and is key to assessing the outcome of implementing various avoid, shift and improve measures.

Damage costs: These assume an average impact on an average population affected by changes in air quality. The approach is recommended by IGCB where the total air quality impact is small (worth <£50 million) and where it does not affect locations where the UK is likely to be in breach of legally binding air quality limits. Whilst this might not always be the case for locations in the LET, it is considered to be an appropriate approach for the purposes of the toolkit. It reduces the complexity of assessment and provides a defensible indication of damage caused or avoided. (An alternative approach is to use the Impact – Pathway approach. This requires detailed dispersion modelling and is therefore more costly and complex to undertake).

Fuel Costs: LET 1.1 contains default fuel costs for 2009 and applies an adjustable inflation rate for subsequent years. The user should note that fuel prices have increased substantially since 2009 and are likely to be volatile in the future. These data are easily adjusted by the user and mechanisms for supporting easy or automatic update of LET 1.1 defaults are under review.

Use of Default Data: Use of default data simplifies the assessment process and reduces data input needs. Where these input data are dependent on the local situation (for example, data on the fleet composition and trip information), it will also inevitably increase uncertainty in the results obtained. Where users are in a position to add local data, this can significantly reduce output uncertainties.

6.3. Transparency

Information on the method and underlying data used by the LET are provided by a wealth of accompanying documentation (such as the Low Emission Toolkit Stage 2 Final Report and the User Guides). This ensures that the user is well informed and transparency is generally high. In some areas, it is acknowledged that additional information would be useful to improve transparency further. These are summarised below, with specific details listed in section 8.4.

Detailed Calculations:
The details of the underlying calculations performed by the LET are not presently described in a simple, clear and accessible manner. It can therefore, for example, be difficult to understand differences between results for two similar scenarios. It is intended that further guidance will be prepared to address this.

Input Data and Assumptions:
There are some cases where the transparency of the input data could be enhanced. For example, it is currently unclear where some of the emission factors for low emission vehicles have been obtained (for example LPG cars). In addition, the source of the CO_2 and CO_2equivalent emissions data is not traceable. As outlined above, the benefits of planning measures being implemented also needs addressing so that a clear and transparent approach is provided. Further work is planned to address these issues.

Outputs
The output data can sometimes lack accompanying information on the units being provided. For example, the fuel efficiency outputs in App1 are provided as “litres/km, Kg/Km, MJ/km”, without specifying which is actually correct. The cost data could also do with further clarification as to what is and is not included; depreciation and discounting for example are not currently taken into account in the data provided.

7 Method Conventions and Constraints

7.1 Conventions

The following specific conventions apply to the LET and assessment methods:

Well to wheel and tank to wheel emissions
The LET currently provides estimates of GHG emissions on a well to wheel basis and air quality pollutant emissions on a tank to wheel basis. Well to wheel emissions take into account the emissions arising from the fuel products life from cradle to grave (from raw materials extraction, processing, distribution and use).

Emission Boundaries
The standard approach for using the toolkit is to consider all trips and emissions arising from the fleet or development site under assessment (i.e. irrespective of where those emissions are made) This is termed the **emission footprint** of the site or fleet. This is the approach currently supported by the LET user guide.

It is also possible to consider **spatially constrained emission scenarios** for a fleet or development site (for example, to explore impact on emissions occurring within an AQMA). This is an extension of the standard method and is not currently supported by the user guide. It is therefore particularly important that any user undertaking the latter type of analysis takes responsibility for ensuring that the approach taken is sound and the results are reported appropriately.

7.2 Constraints

Assessment using LET 1.1 is subject to the following constraints:

Scope of Technologies
The **scope of low emission vehicles** has been restricted to those for which there is reliable data currently available on fuel consumption, emissions and costs. This means that technologies that are not thought to be commercially viable before 2015 are not presented.

Hydrogen vehicles are included within the LET, but default data is not provided (i.e. the user would need to provide their own emission factors and cost data).

Plug-in hybrids and motorcycles are currently missing from the toolkit as is the option to assess the impact of retro-fitting selective catalytic reduction devices to heavy duty vehicles.

Cold Start Emissions

The toolkit provides hot exhaust emissions as well as tyre and brake wear**. Cold start emissions** are not included. This is consistent with the approach adopted by Defra's Emission Factor Toolkit. It is not considered appropriate to include the emissions arising from cold start emissions within the LET, as the data would be uncertain at the local level and it would make the tool unnecessarily complex.

8. User Advice and Known Issues

8.1 General Approach

The LET is intended for use by technical but non-specialist users. It has been designed to be highly flexible, allowing best use of available data and supplying default options wherever possible. It has also been designed to allow tailoring of most parameters and data sets.

Inevitably, this level of flexibility adds a significant choice of approach and therefore some complexity. The tool, in its current form, is not advised for a minor one-off or in-frequent use. Maximum value is likely to be gained through sustained use either on a single large project, or part of on-going action planning/low emission strategy design, development and implementation (i.e. thereby establishing user competency, local standards for use and, for example, local templates/short cuts for scenario definition).

The LES Partnership currently maintains an informal user group and is developing plans for on-going support and engagement as the tool gains wider adoption and use (see www.lowemissionstrategies.org.uk)

8.2. Method Notes

The LET uses data that are consistent with other LAQM tools and are based on well referenced datasets where possible. It uses a sound approach to calculating the emissions and costs of different low emission scenarios. The toolkit and general approach are considered appropriate for meeting the needs of Local Authorities in conducting low emission strategy assessments. However, a number of uncertainties and issues remain, which require careful consideration by the user in order to ensure appropriate interpretation and presentation of results obtained from the LET.

Specific care and attention should be given to the following aspects of use:

Combining Measures: The impacts of measures are considered by the LET to be additive. The user needs to ensure that packages of measures are constructed to reflect this. Until specific guidance can be provided on this issue, it is important that any user wishing to combine packages of measures using the LET makes sure they understand clearly how the toolkit calculates the impact of multiple measures.

Option Appraisal: At present the LET only provides the user with the combined impact of all of the measures selected. Consequently comparing different options or combinations must be done manually, using either multiple components or copies of the toolkit.

8.3 Known Data Issues

Known data issues affecting LET 1.1 have been outlined in Section 6 and are summarised below:

- Mileage degradation and fuel improvement factors have not been taken into account in the emission factors used for standard vehicles;
- The CO_2e emission factors for each fuel are in need of updating;
- The CO_2e factor for renewable electricity should be deleted from the LET;
- The fuel prices are based on 2009 information and corrected for inflation. However, fuel prices have been volatile and therefore care should be taken when using the data;
- The data presented for new fuels and technologies is subject to uncertainty due to the lack of data available for some emerging vehicle types;
- The impact of planning measures are uncertain.

8.4 Known Guidance and Documentation Issues

Whilst substantial documentation has been produced alongside the LET, there are two main areas that would still benefit from some additional information. They are:

- Concise but comprehensive documentation, which is accessible to the user, on the sources of information utilised as input data to the toolkit;
- A more detailed description of how the input data is used to generate the resulting emissions and emission savings (i.e. building on the overview presented in this report).

Appendix A: LET Datasets

Table A1: LET datasets (v1.0) – datasets and data structures contained within the LET

Nos	Data Set	Permutations / Data Points	Description
1	Veh-Tec combos (standard)	295	Subset of DfT vehicle classn scheme: drive train (ICE), fuel (petrol/diesel), vehicle type/weight (multiple) and emission standards (multiple) => Car (79), LGV (48), HGV (117), bus (36), coach (15) => 295
2	Veh-Tec combos (low emission)	346	Dataset structure: Drive Train (7): ICE, Fuel Cell, EV and hybrid (full parallel, full series, mild) Fuel (12): Gasoline, Diesel, Natural gas / Biomethane, Electric, Biofuels (E85, ED90, B30, B100, PPO) vehicle type (14): HGV (4 sub-types), Bus (2-3 sub-types), MGV, LGV, Car (2-3 subtypes), Retrofit (3): DPF, EGR, SCR LET (v1.0) coverage: LET v1. includes those for which: Prototype/pilot, Demo/trials, Limited scale production and/or Mass scale exploitation are known. It excludes combinations which do not exist or are not expected to exist (other than in Research or Proof of Concept form) by 2015 => LET v1.0 includes 347 vehicle-technology combinations => comprising (Bus (37), taxi (12), car N2.5 (50), car 2.5-2.3 (17), coach (24), HGV artic (60), HGV rigid (98), LGV N1, I-III) (48)
3	Fleet Composition	22125	Location (London / Not London and Predominant journey type (Urban, rural, motorway) to reflect UK national fleet compositions. 5 fleet compositions (no London rural) each providing relative activity of standard VT combos from 2010 to 2025 (DP = 5x295x15 = 1785)
4	Emission Factors	7692	In the LET an average emission for each of the urban, rural and motorway fleets has been created at a typical speed. The speeds vary for the different road types. When a user specifies urban, rural or motorway as the Predominant journey type the LET will therefore use emission factors for different fleets and different average speeds. => 3 (Predominant journey type) x 4 (pollutant - PM1, PM2, CO2, NO_X) 12 emission factors per VT combo (295+346 = 641) => 7692 emission factors (excl any data gaps).
5	Cost Data (standard)	1180	Capex (min/max) and opex (min/max) for all VehTec combos (294x4)
6	Costs Data (low emission)	1384	Capex (min/max) and opex (min/max) for all VehTec combos (346x4). Note also: additional calculator provided for dual fuel costs.
7	Infrastructure Costs	132	Capex (min/max) and opex (min/max) for all 11 fuel types (Diesel, Natural gas / Biomethane, Hydrogen, Electric, Biofuels (E85, ED90, B30, B100, PPO), with Low/Med/High options
8	Energy/ Carbon Factors	28	Assumed Energy content and Carbon content off different fuels (with variants) = 14x2)
9	General defaults	78	Fuel prices (12 fuels x min/max), CO2 damage (min/max for 2010-2025), AQ damage costs (PM/ NO_X, min/max plus location options for PM_{10}), plus payback period and inflation rate
10	Trip Related Defaults	1000	(i) Trip Lengths: Table provides defaults by: vehicle type (Cars/Bus), region (London/Not London), broad journey purpose (7 categories), also HGV by size/type (9) [~50dps] (ii) Trip Rates: Car/Bus/HGV(3), London/Not London(2), Land use broad (5) broken down as narrow (36) = 3x2x36 = estimated 216 trip rates [~840dps] (iii) Trip Rate Conversion factors by land use type (5) car/bus for peak/daily data also by , for HGV just as daily [total ~17dps] (iv) Annual Average distances [car/bus - London not London = 4dp, HGV by size/type = 14dps] (v) Land Use - Trip Purpose translation table: presents the categories uses within the LET and correlates land use (broad(5)/narrow(36) with trip purpose (5)
	Total =>	**34260**	

Appendix B: Key references

LET Documentation

Low emission toolkit, Stage 2 final report. Version 1.1 January 2011. Report prepared for LESP by TTR, CERC and RPS.

Low Emission Toolkit Stage 1 Planning Based LET Measures (Development) Report. Report prepared for LESP by TTR, CERC and RPS.

Low emission toolkit user guide, January 2012

Low emission toolkit quick start guide, January 2012.

For a full list of data references, please see the accompanying data tables.