How does our choice of transport affect climate change?

The type of transport we choose to use can have a major impact on climate change. Below is a quick reference table showing the average emissions resulting from different transport modes. By switching from private land transport (car or van) to walking or cycling we can save 100% of our contribution to climate change; by switching to public transport (train or bus) we can save 50% or more. Air travel will always have a greater impact than travel by land or water, although there is much discussion about the best approach to calculating it. Changing our transport habits will not always be possible, but it may be worth thinking more carefully about how to get around. We may find the freight figures relevant in discussions on shopping and business habits, especially in relation to items such as food and flowers that require long-distance air freighting.

How do the transport modes compare?

The table below is based on selections from government data and the accompanying methodology paper published in April 2013, and, where appropriate, we have factored in Winchester-specific conditions. See below for full explanatory notes and more detail if you wish to do your own calculations reflecting specific circumstances.

Passenger Transport

<table>
<tr><th>Mode</th><th>Type</th><th>Other description</th><th>gCO_2e / whole vehicle km</th><th>gCO_2e/pkm</th><th>Notes</th></tr>
<tr><td>Air</td><td>UK</td><td>Average class</td><td></td><td>362.23</td><td rowspan="3">Includes a distance uplift of 8% to compensate for planes not flying using the most direct route i.e. flying around international airspace, stacking etc. and a 90% increase in the CO_2 factor to account for radiative forcing (the influence of the other climate change effects of aviation (water vapour, contrails, NOx etc))</td></tr>
<tr><td>Air</td><td>Europe</td><td>Average class</td><td></td><td>213.45</td></tr>
<tr><td>Air</td><td>Intercontinental</td><td>Average class</td><td></td><td>251.24</td></tr>
<tr><td>Car</td><td>small</td><td>unknown fuel</td><td>187.26</td><td>167.20</td><td rowspan="5">The government figures include a 15% uplift to allow for ‘real-world’ conditions. Assumes passenger occupation of 1.15 people (including the driver) based on figures given in the ICM Hampshire Transport Survey December 2011.</td></tr>
<tr><td>Car</td><td>medium</td><td>unknown fuel</td><td>230.21</td><td>205.54</td></tr>
<tr><td>Car</td><td>large</td><td>unknown fuel</td><td>303.1</td><td>270.63</td></tr>
<tr><td>Car</td><td>average</td><td>unknown fuel</td><td>229.58</td><td>204.98</td></tr>
<tr><td>Car</td><td>average hybrid</td><td>petrol/electric</td><td>157.24</td><td>140.39</td></tr>
<tr><td>Car</td><td>Nissan Leaf</td><td>electric</td><td>96.6</td><td>84</td><td>While there are no tailpipe emissions, there are significant emissions in the production of the electricity. The government has not yet produced figures, so these figures are based on a CEGB calculation that assumes like-new performance. We have</td></tr>
</table>

Mode	Type	Other description	gCO_2e / whole vehicle km	gCO_2e/pkm	Notes
					added a 15% uplift to allow for 'real-world' conditions. Assumes passenger load of 1.15 people (including the driver). There have been complaints that the range deteriorates rapidly once the vehicle is on the road and that the emissions per km increase correspondingly.
Motorbike	average		142.25	**127.01**	Assumes passenger load of 1.15 people (including the driver).
Taxi	regular taxi (not black cab)			**349.97**	Assumes occupancy of 1.5 people, excluding the driver, (TfL figures for London) and adds in an empty return journey that doubles the gCO_2e/pkm figure.
Bus	Romsey Road Average		1419	**115.29**	Assumes occupancy of 12.31 passengers, based on WinACC survey of Romsey Road buses in March 2012). Whole bus emissions of 1419 g/km.
Coach	National Travel			**35.47**	A whole coach emits 574.61 g/km, and National Travel claim an average occupancy of 16.2 passengers.
Train	UK average			**57.58**	Based on Office for Rail Regulation average national figures for the current mix of diesel and electric trains. Most trains serving Winchester are electric-powered and emit 30 per cent less than diesels. All Winchester's services will be electrified over the next few years. Meanwhile Cross-Country trains are diesel-powered, as are a few local trains.
International Train	Eurostar			**14.29**	Figures based on the power mix used by Eurostar and are reduced because of their extensive use of nuclear power Other European and high speed railway operators will have different results.
Ferry	foot passenger			**22.89**	Based on research on ferries that carry both passenger and freight vehicles. Passenger-vehicle-only ferries are likely to have higher emissions per passenger
Ferry	car passenger			**158.18**	
Bicycle			**0.00**	**0.00**	
Foot				**0.00**	

Freight Transport

Mode	Type	Other description	gCO_2e/tkm	Notes
Air	UK		**4588.16**	Same uplifts as for air passenger emissions. Mostly on freight-specific flights
Air	Europe		**2853.03**	Same uplifts as for air passenger emissions. Mostly on freight-specific flights
Air	intercontinental		**1451.53**	Same uplifts as for air passenger emissions. Much international freight is carried on passenger flights. The weight of passenger-specific equipment is taken into account in the apportionment
Vans	average up to 3.5 tonnes	average load	**645.90**	
Large Goods Vehicles (HGVs)	average size	average load	**149.77**	Rigid chassis lorries emit higher levels (301 gCO_2e/tkm) than articulated lorries (107 gCO_2e/tkm) though this might be a reflection of the predominantly local nature of rigid lorry journeys.
Train	overall average		**32.91**	Based on the actual UK mix of diesel and electric hauled trains given by the Office for Rail Regulation
Boat	container ship	average	**22.91**	General cargo ships perform similarly
Boat	bulk carrier	average	**5.99**	
Boat	ro-ro ferry	average	**52.85**	

General Notes and Explanations

In the table, all greenhouse gas, of whatever type, is converted into the grams of CO_2 that would have the equivalent effect on global warming (grams of CO_2 equivalent or gCO_2e). The table compares how much gCO_2e each transport mode emits to transport a person a distance of 1 kilometre - gCO_2e/pkm, or a tonne of goods a distance of 1 kilometre - gCO_2e/tkm). Average loadings are assumed. The data include both ‘direct’ emissions created on the journey itself and ‘indirect’ emissions caused before the journey (eg production, refining and delivery of fuel – “well-to-tank”).

‘Embedded Carbon’

The CO_2 equivalents emitted in the construction of the vehicles and infrastructure for each mode (the embedded carbon) has not been included in the calculations because the data is not readily available, and it would not be possible to calculate this directly until the end of an item’s life. This would require a great deal of data on how that item was used. Once a satisfactory methodology has produced reliable averages for the embedded carbon for each mode, embedded carbon will become an important part of the overall picture.

"Real World" rather than Brand New Vehicles or Good Driving Behaviour

Figures for road vehicles are 'real-world' data and follow government practice that adds 15% to manufacturers' quoted figures to allow for reduction in efficiency caused by wear and tear and everyday use. Manufacturers' figures are established in tests on carefully prepared new vehicles in ideal conditions. Approximately a further 21% has been added for well-to-tank emissions using government data where it is available and following their methodology in other cases. As far as possible the approach has been consistent for all transport modes and fuels, so that the figures are comparable.

Average driving behaviour is probably also assumed in the government data, so wherever drivers determinedly and consistently accelerate slowly, limit their top speed, cruise frequently, brake carefully, and do not use their gears to slow down there will presumably be some reduction in emissions, whatever the transport mode. Conversely, where drivers are in a hurry there will be an increase in emissions. The extent of this effect has not yet definitively been quantified.

Exact approximation

The figures in the table are approximate, but have been given to 2 decimal places to reduce any distortion that may occur in large calculations. The government data they are based on give data in kilograms to six decimal places.

When is a Driver also a Passenger?

In the calculations to establish gCO_2e/pkm for buses, trains, and taxis, drivers and other crew have been excluded from the passenger numbers. Similarly cabin crew have been excluded from air passenger calculations. With cars, vans and motorbikes the situation is more complex. Normally, if drivers are making journeys for their own benefit, they should be included in the passenger occupancy calculations. In the Winchester area, for example, most car journeys are made by the driver only for their own benefit, so that in these cases the driver should also be treated as a passenger. In a small number of cases they are joined by one or more additional passengers, with the result that the average car passenger load is 1.15 people, including the driver, and they have all been included in the 'gCO_2e/pkm' calculation. Any remaining chauffeurs acting professionally should be excluded from the 'gCO_2e/pkm' calculations.

What about situations examples in the tables don't cover?

A customised spreadsheet of the government-published data that covers a greater range of circumstances can be downloaded from:

http://www.ukconversionfactorscarbonsmart.co.uk/Filter.aspx?year=27

Make sure you tick the boxes for all the options you need. You can find other relevant government documents at:

https://www.gov.uk/measuring-and-reporting-environmental-impacts-guidance-for-businesses

The figures in the table above are mostly average or typical figures. In the Winchester area, for example, average car loads are about 1.15 passengers per car, so the figures in the table reflect this and are useful for calculating car emissions generally. If, however, you wish to calculate the emissions per passenger kilometre for a specific journey, you can, where it is available, take the figures for a specific type of whole vehicle and divide that figure by the number of passengers in it. The figures we have used are fairly generic, but the government provide more detailed whole vehicle emission figures for specific types of car, and specific types of fuel on the website referred to above. Unfortunately they have not yet published figures for electric vehicles. However National Grid publish emission figures at http://www.owningelectriccar.com/UKnationalgrid.aspx updated in real time for different makes of electric car, to reflect the current mix of electricity. They appear to include indirect emissions for the electricity, but you will need to add 15% to get 'real-world' figures comparable to the ones in the table.

If you prefer, for specific makes of car, you can take the manufacturers' figures as advertised and uplift the figures by 40% to reflect the combined 'real-world' performance (15%) and the 'indirect' well-to-tank emissions (21%), to get comparable whole vehicle data.

Similarly you can calculate the specific emissions for a bus journey you make, by dividing whole vehicle emissions by the number of passengers on the bus. The result will be approximate because in their emissions data the government do not distinguish between different types of bus. Double decker whole-vehicle emissions will be slightly above the average figure, and single decker whole-vehicle emissions slightly below the average figure. The difference is surprisingly small, compared with the difference caused by the number of passengers. With trains and planes this type of calculation is not possible because the government do not publish whole vehicle data, or average occupancy figures; gCO_2e/pkm is all that is available.

Awkward cases: taking people to the station, taking children to school etc

When, for example, we collect a visitor from the station, or take a child to school, but as the driver we return to the starting point, the gCO_2e/pkm will be higher than normal. The car will travel twice as far as the functional journey. For example, when we set out especially to collect a single visitor for a two kilometre journey from the station, the passenger will travel two kilometres, but the car will have travelled four. The driver, who is in this case an agent and does not directly benefit from the journey, should not be included as a passenger. This will give a gCO_2e/pkm of twice the whole vehicle figure. For an average car this will give emissions of 409.96 gCO_2e/pkm, a higher rate of emissions than for UK air travel. (If there are two passengers this figure will of course halve, and so on) Similarly, Winchester district taxis generally return to their starting point and produce a very high rate of gCO_2e/pkm emissions.

How can we plan for the future?

There is a lot of activity targeted at reducing greenhouse gas emissions from transport and it is difficult to predict how things will pan out on a number of key developments:

- **Electric Cars**

  Much hope has been placed on electric cars for reducing transport carbon emissions. Their zero tailpipe emissions will certainly help reduce localised atmospheric pollution of the sort we experience in Winchester. However a number of issues need to be resolved before they are a significant positive factor in reducing carbon emissions:

  - The electricity they rely on will produce substantial carbon emissions until the UK electricity grid supply is close to zero carbon
  - The electricity distribution system is inadequate for handling the mass evening recharging that would take place if all cars were electric.

  Some factors, however, may prove even more difficult to address:

  - They will always suffer from the inherent inefficiencies caused by the rolling resistance of rubber tyres on road surfaces
  - They will always suffer from the inherent inefficiencies of small private transport units which are often relatively empty (in Winchester about 1.15 people per car) and be a relatively inefficient use of transport energy.

  Achieving a zero carbon electricity supply will be challenging, especially if, in addition to replacing the carbon-emitting electricity we currently use, we also want electricity to replace the energy we currently obtain from coal, gas, and oil, for travelling around, heating our homes etc. On present plans, there will be far less energy available than now and we will have to rely on reducing the energy requirement. We will have to be ruthless in ensuring that only the most efficient transport modes are used. Ultimately, there may be such an emphasis on energy saving, that electric cars may begin to feel as gratuitously wasteful as uninsulated roofs do now.

- **Electric trains**

  Much more immediate will be the progressive electrification of our railways. Network Rail has undertaken to reduce the emissions of the rail system by 30% by 2019 by electrification, reducing train weight, removing bottlenecks etc. This will have a major impact on the figures in the table for both freight and passengers. The biggest electrification scheme (the 'electric spine') directly affects Winchester. It will completely renew the electrification system between Southampton and Basingstoke with a more efficient system, electrify routes to the Midlands, North West and North East, convert Cross-Country trains to electric power, and enable freight trains to be electrically hauled to most parts of the country.

- **Low emission buses**

  The Department for Transport are promoting low emission buses (e.g. hybrid, electric, hydrogen), and the Mayor of London is sponsoring much development work. Carbon-saving measures are easier on large vehicles than small vehicles – they have more room for batteries and hydrogen tanks. Electric local buses will be able to recharge regularly at the end of each journey so will not suffer from the range limitation that hampers the electrification of private vehicles. This all suggests that progress will be easier with local buses than it will be with private transport.

  Already it appears that new buses in London will have a major impact on emissions. Hybrid buses will have lower emissions and future updates of our table may show how much this is. According to the manufacturers of the hybrid New London Routemaster (on the Wright bus website) the engineering test vehicle "emitted only 640 grams per kilometre (g/km) of CO_2 and 3.96 g/km of oxides of nitrogen (NOx) – less than half of the CO_2 emitted by a current diesel bus and under half of the NOx emitted by a current diesel bus" (http://www.wrightbus.com/site/default.asp?CATID=78). Ultimately trams operating directly on zero-carbon electricity could replace buses on high frequency routes in many towns.

- **Aircraft**

  Manufacturers claim that the latest generation of aircraft show a 20% reduction in emissions per passenger or tonne / kilometre. However, aircraft will probably always rely on kerosene for their fuel and still have a far greater impact on climate change than other modes of transport. The promised rate of greenhouse gas reduction is less than that proposed for UK trains. Despite the rhetoric from the air industry, overall there has been a halt in the growth in air traffic since 2007, suggesting that the additional infrastructure advocated by many commentators may be unnecessary, as well as undesirable from a climate change perspective.

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