Data / Methodology

This document outlines the data, calculations and assumptions in a series images depicting greenhouse gas emissions from road transport.

General points

The aim of volumetric representations is to provide a 'feel' for the quantities involved. This visualisation technique lends itself to small data sets or single values and is especially useful for audiences who are not actively engaged with the data.

We used emissions data supplied by ERM (www.erm.com).

To calculate volumes we used a value for the density of carbon dioxide gas at 1 atm (101,325 Pa) and 15 °C:

$\rho_{CO_2} = 1.87$ kg.m^{-3} (Source: CO_2 – Air Liquide Gas Encyclopaedia)

Volume = Mass / Density

Total road transport emissions

Carbon dioxide emissions from road transport in the UK would fill a cube 363 metres high every day. This is the actual volume of daily road transport emissions displayed as carbon dioxide gas. 58% of UK emissions are from personal transport. (Latest available figures are for 2007.)

Calculation

For daily values, we divided the annual values by 365.

$$v = \frac{m}{\rho_{CO_2}}$$

Cube dimension: $d = v^{\frac{1}{3}}$

Data

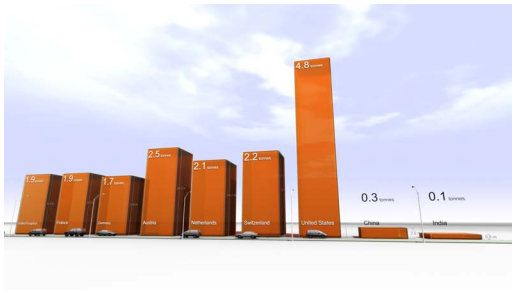
Country	Total annual road transport emissions inc. freight etc. (million tonnes CO_2)	Source*
United Kingdom	32.7	Department for Transport Low Carbon Transport Innovation Strategy, 2007, Chapter 2: The need for a Low Carbon Transport Innovation Strategy
France	124.0	United Nations Framework Convention on Climate Change Fifth National Communication of France, November 2009
Germany	144.0	European Commission, EU energy and transport in figures 2010 CO_2 Emissions from Transport – 2007 by mode
Austria	23.2	United Nations Framework Convention on Climate Change Fifth National Communication of the Austrian Federal Government, November 2009
Netherlands	34.5	European Commission, EU energy and transport in figures 2010 CO_2 Emissions from Transport – 2007 by mode
Switzerland	15.8	European Commission, EU energy and transport in figures 2010 CO_2 Emissions from Transport – 2007 by mode

* Data supplied by ERM (www.erm.com).

Country	Total annual personal road transport emissions (million tonnes CO_2)	Source*
United Kingdom	19.1	Department for Transport Low Carbon Transport Innovation Strategy, 2007 Chapter 4: Low Carbon Technologies and the Road Sector
France	67.5	United Nations Framework Convention on Climate Change Fifth National Communication of France, November 2009
Germany	96.0	OECD European Conference of Ministers of Transport Cutting CO_2 Emissions: What progress? Summary document 2007 "Passenger transport emissions represent 2/3 of total road transport emissions in OECD countries as a whole"
Austria	13.2	United Nations Framework Convention on Climate Change Fifth National Communication of the Austrian Federal Government, November 2009
Netherlands	23.0	OECD European Conference of Ministers of Transport Cutting CO_2 Emissions: What progress? Summary document 2007 "Passenger transport emissions represent 2/3 of total road transport emissions in OECD countries as a whole"
Switzerland	10.5	OECD European Conference of Ministers of Transport Cutting CO_2 Emissions: What progress? Summary document 2007 "Passenger transport emissions represent 2/3 of total road transport emissions in OECD countries as a whole"

* Data supplied by ERM (www.erm.com).

Per capita emissions from road transport



Actual volume of annual per-capita carbon dioxide emissions from road transport. This the quantity of carbon dioxide gas from road transport shared amongst each person in each country – not each driver nor each car. The data are the most recent available (2008).

Annual per-capita emissions targets for 2025 (UK) or 2020 (others). The dashed line shows a comparison with latest emission figures. In the case of France and Austria the targets are greater than current emissions. The image shows the actual volume of carbon dioxide gas.

Calculation

For ease of visual comparison, the towers vary in one dimension only, which means a volume twice as large will be twice as tall. The base of the columns is 8.12 metres square because a cube with dimensions 8.12 metres contains a tonne of carbon dioxide gas, which means that the columns are like stacks of one-tonne cubes.

Height, $h_{metres} = \frac{m_{\text{tonnes}}}{u_{tonnes}} . \left(\frac{1000 . u_{tonnes}}{\rho_{CO_2}} \right)^{\frac{1}{3}}$

Where m_{tonnes} is the emission mass or target mass in tonnes of CO_2(e) and u_{tonnes} is the base unit mass in tonnes (1 tonne in this case).

Data

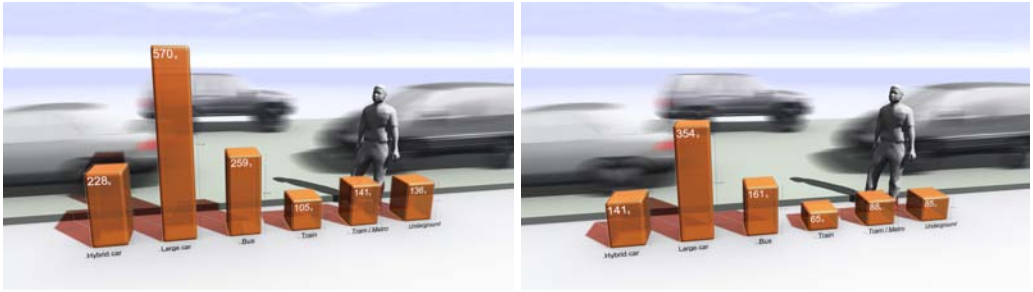
Country	Average annual driving emissions per capita, 2008 (tonnes CO_2)	Source*
United Kingdom	1.870	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
France	1.850	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
Germany	1.700	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
Austria	2.500	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
Netherlands	2.060	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
Switzerland	2.200	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
United States	4.781	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
China	0.251	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008
India	0.106	IEA Statistics, CO_2 Emissions from Fuel Combustion Highlights, 2010 Edition Per capita emissions by sector in 2008

* Data supplied by ERM (www.erm.com).

Country	2020 Target average annual driving emissions per capita (tonnes CO_2)	Sources*
United Kingdom	1.37 (2025 target)	Emissions: Department of Energy and Climate Change Energy Emissions projections Update projections (June 2010) Annex B: Carbon Dioxide Emissions by Source, Road Transport Carbon Dioxide Emissions Projections: 94 Mt CO_2 for 2025, Central prices, central growth, central policy, Low Carbon Transition Plan Population: Office for National Statistics, 2008-Population projections, Data table: Components of change and summary indicators (UK)
France	2.00	Emissions: The fifth National Communication of France to the United Nations Framework Convention on Climate Change, November 2009 Population: Institut National d'Etudes Démographiques (INED) Evolution passée et future de la population, selon le scénario central et les six variantes retenues 2007
Germany	1.26	Emissions: UNFCC Fifth National Report of the Government of the Federal Republic of Germany, November 2009 Population: Statistiches Bundesamt Deutschland (Federal Statistics Office) Germany's Population by 2060 Results of the 12th coordinated population projection, November 2009
Austria	2.93	Emissions: UNFCCC, Fifth National Communication of the Austrian Federal Government, November 2009 Population: Statistics Austria, Population forecasts, Results (overview): Austria, November 2010
Netherlands	1.89	Emissions: Energy Research Centre of the Netherlands, Sustainable Innovations in Road Transport: Assessing the Impact of New Technology on Energy Use and Emissions Population: Fifth Netherlands National Communication under the United Nations Framework Convention on Climate Change, December 2009
Switzerland	1.52	Emissions & population: UNFCCC Switzerland's Fifth National Communication under the United Nations Framework Convention on Climate Change, December 2009

* Data supplied by ERM (www.erm.com).

Emissions per passenger mile / km



Actual volume of greenhouse gas emissions per passenger mile (left) or per passenger kilometre (right) for different forms of transport, expressed in terms of CO_2(e) – carbon dioxide equivalent. (Figures for cars relate to the driver only.)

Calculations

For ease of visual comparison, the towers vary in one dimension only, which means a volume twice as large will be twice as tall. The base of the columns is 38 cm square because a cube with dimensions 38 cm contains 100 grams of carbon dioxide gas, which means that the columns are like stacks of 100 gram cubes.

Height, $h_{cm} = 100.\frac{m_g}{u_g}.\left(\frac{u_g}{1000\rho_{CO_2}}\right)^{\frac{1}{3}}$

Where u_g is the unit mass for the base of the tower in grams (100 grams in this case) and m_g is the mass of emissions in grams.

Conversion from miles per UK gallon to kilograms of CO_2(e) per kilometre (for car data):

CO_2(e) per litre of petrol consumed: C_{kgl} = 2.7329 kg (All scopes) Source: 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting, Version 1.1 (final) 06 Oct 2010 p 25

1 mile = 1.609344 kilometres

1 UK gallon = 4.54609 litres

Efficiency in terms of kg CO_2(e) per km: $E_{kgkm} = \frac{4.54609}{1.60934}.\frac{C_{kgl}}{E_{mpg}}$

Where E_{mpg} is efficiency in miles per gallon and C_{kgl} is CO_2 (e) per litre of petrol consumed

Data

	mpg*	kg CO_2(e) per km (calculated)
Hybrid car	54.6	0.1414
Large car	21.8	0.3541

* Data supplied by ERM (www.erm.com)

	kg CO_2 per passenger km (all scopes)**
Bus	0.16084
Train	0.06510
Tram / Metro	0.08761
Underground	0.08457

** 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting, Version 1.1 (final) 06 Oct 2010 p 22