# Cars and climate change: decarbonising passenger road transport

**Rachel Freeman, University of Manchester,** **looks at why reducing carbon emissions in the UK transport sector is only happening very slowly, and how it can be sped up.**

Most of the UK's major sectors (power, buildings, waste and industry) are making slow but steady progress towards a low greenhouse gas (GHG) emissions future – guided by the Committee on Climate Change's GHG budgets to 2050.[1] Emissions from the transport sector, however, have barely fallen against a 1990 baseline, and transport has now taken over from power as the highest emitting UK sector.[2] In this article, I will explore why transport has proved so difficult to decarbonise compared to other sectors by focusing on the largest part of transport emissions – $CO_2$ emissions from passenger cars. Cars were responsible for 17% of total UK $CO_2$ emissions in 2015 (up from 6% in 1970) and made up 58% of transport emissions.

The causes of $CO_2$ emissions can be formulated as a straightforward equation:[3]

> Annual emissions (grams of carbon dioxide, $gCO_2$) = total travel consumption per year (km) x average energy intensity of travel (megajoules/km) x average carbon intensity of energy used ($gCO_2$/megajoule)

Since this formula is multiplicative, a rise in one or more factors will counteract a fall in others. For example, if energy efficiency improves (i.e. the energy intensity of travel falls) but travel consumption rises at the same rate then emissions will remain the same.

Let's examine some of the key issues related to the three terms within the formula for the UK.

### Travel consumption

Since the early 1970s several trends have been seen in travel consumption. Firstly, the average distance travelled by all modes, per person per year, has risen by around 70% - from 7,300 to 12,300 km/person/year. While the average number of trips per person has remained stable, the average length of trips has increased. Another change is that around 80% of personal travel is now by car, with the most common reasons for travel being shopping and personal business. Finally, the cost of car ownership has fallen by around a third and there has been a corresponding increase in the size of the UK's car fleet, rising by half since 1994.[4] Ownership of vehicles has become easier recently with Personal Contract Purchase financing, which requires no deposit and little proof of income – also linked to a trend for larger cars which have higher emissions.

There are many reasons for this normalisation of the car as the primary mode for everyday travel: it is convenient, fast (when not in traffic jams), and provides a private space. It's affordable for most people and often cheaper than public transport. It enables people to work more than one job should they need to, especially at unsociable hours, or live in places unconnected by public transport. It offers a sense of safety to concerned parents and those who feel vulnerable walking, cycling or traveling on public transport. It allows people to transport a large volume of belongings. The UK has a strong car culture, with peer pressure, personal status, and pleasure bound up with owning and driving a car that suits one's self-image.

### Energy intensity of travel

A rough estimate, calculated by dividing total $CO_2$ emissions from cars by the total distance driven, indicates that the average energy efficiency of the UK fleet of cars has improved by around 30% since 1970, dropping from 245 $gCO_2$/vehicle-km to 172 $gCO_2$/vehicle-km. The efficiency of moving people has decreased less, however, falling from 150 $gCO_2$/passenger-km in 1970 to 132 $gCO_2$/passenger-km in 2015 – a drop of only 12%. This indicates that the utilisation rate of vehicles has decreased. Thus, some of the benefits of vehicle efficiency have been lost as cars are being used with fewer passengers. This lower utilisation is partly influenced by the volume of personal belongings people travel with and the desire for convenience and privacy.

### Carbon intensity of energy

Almost all UK car travel is currently fuelled by oil-related fuels – petrol, diesel, LPG, CNG, and LNG. In 2015 electricity accounted for less than half a percent of the tonnes of oil equivalent used in road passenger transport, while bioliquids accounted for 3%.[5] Thus, the carbon intensity of fuel is basically that of fossil fuels and has not fallen.

Interactions between consumption, energy intensity and carbon intensity are important. For example, direct 'rebound' occurs when the cheaper cost of a service, achieved through an improvement in energy efficiency, leads to users consuming more of that service. Rebound erodes expected savings from energy efficiency, and for transport it has been estimated at 19% in the UK.[6]

### Possible solutions: how to unstick road transport and decarbonise

Many solutions have been proposed to decarbonise transport. A study from 2007 found that a 60% reduction in transport emissions by 2030 was possible but it would require "an integrated package of technological and behavioural policy measures, ensuring that we travel in more carbon efficient ways and we travel little further than at present".[7] In the 10 years since that article was published passenger car emissions fell by 10% – a slow start towards the 60%.

One problem with considering only decarbonisation is that other negative side effects of mass privatised car use are neglected, including: urban air pollution from emissions such as particulates and NOx (especially from diesel cars); road building that takes away land from other uses; noise pollution; clogged up streets; lost economic output and human stress due to traffic congestion; social exclusion (for those without access to a car); impediments to public transport (e.g. buses getting stuck in traffic); road traffic collisions; and a lack of active travel contributing to ill health.

The reasons for the slow decarbonisation of transport are probably obvious. Car travel is just too attractive and its negative side effects are not fully valued. Energy efficiency gains have been partly offset by lower vehicle utilisation, longer trips, and larger cars.

Improvements to driving conditions, such as smart motorways, are making driving easier. Easy financing makes owning a new and impressive car more accessible to more people. The car sector and its supply chain is enjoying a boom, and the Treasury is probably not too keen on disrupting it. The general expectation seems to be that decarbonisation will happen solely through changes to vehicles and fuels. However, this may not be the quickest, most efficient or most economic route.

In addition to expanding support for public transport, cycling and walking, which have many other benefits in addition to $CO_2$ savings, there are several possibilities:


This Nissan Leaf electric car is operated by a car club and charged from community-owned renewable energy technologies near Lancaster. Will such options become commonplace?

1. A new business model, known as 'mobility as a service' would combine autonomous (driverless) vehicles, low-emissions vehicles (e.g. as part of a car club[8]), smart devices (e.g. apps on phones), and smart roads (e.g. live traffic data). Personal, door to door transport could be provided as scheduled or on-demand driverless vehicles (of various sizes), which are centrally coordinated to maximise road use efficiency. Many households, especially in cities, would no longer need to own cars. Imagine how much more physical space would be available for walking, cycling, and even socialising. It would reduce road traffic collisions, prevent isolation for non-drivers, reduce noise, and reduce the stress that comes with having to navigate clogged up streets. It would, however, need a huge amount of investment to make it work and it could put some public transport networks out of business.
2. An option for replacing fuel tax that would please the Treasury is dynamic road pricing. Car owners/users would pay a dynamically changing fee to use roads, which would rise as the demand for particular types or sections of roads rise.
3. An option for increasing active travel is the electric bicycle, which is becoming very popular in China and gaining market share in the UK. This offers some exercise but is not as daunting as a fully mechanical bike for those who are less fit.
4. Fully electric cars are a good option but not necessarily the best for all driving. With the current carbon intensity of grid electricity (242 $gCO_2$/kWh), the Nissan Leaf emits around 36 $gCO_2$/km (not including the high embodied emissions in a large traction battery) but with a range of only 250km. A petrol hybrid car like the Toyota Prius is rated at 70 $gCO_2$/km and hybrids are better as an all-round car since they have longer ranges between fuel stops. There are also many highly efficient petrol or diesel cars that are rated at less than 100 $gCO_2$/km. Furthermore, the implications of electrification are that deep $CO_2$ savings will only be achieved with a simultaneous large-scale and rapid building programme for low-carbon electricity generation. It is notable that, for example, the National Grid's 'High EV' scenario shows an increase of over 15% in electricity supply by 2050 over their 2°C scenario, some of which would come from natural gas[9] – with potential impacts on the carbon intensity of grid energy.
5. All non-electric cars still need liquid fuels, however. One option would be to replace petrol with low-carbon synth fuels, such as synthetic methanol, which can be made from low-carbon electricity and waste $CO_2$.[10] For example, Audi e-gas, which is produced through a two-step process of electrolysis and methanation[11], is being compressed as CNG and used in the dual-fuel Audi A5 Sportback g-tron[1]. Audi claim that the car emits "80% less $CO_2$/km with Audi e-gas technology purely in gas mode (CNG)"[12] compared with a similar petrol fuelled model. However, synth fuels would still require a large input of electricity from renewable sources.

A combination of the partial replacement of private cars with mobility as a service, dynamic road pricing, promotion of active travel (walking and cycling), hybridisation or electrification of cars, low-carbon synthetic fuels, and support for public transport might make a much larger dent in our car transport emissions than assuming the car fleet is going to be decarbonised through technology changes alone. Finally, we might, as a society, stop to question our high-powered lifestyles. Most of us don't think twice about taking cross country journeys in vehicles with the power of over 100 horses. Our great-grandparents might have taken such a journey only a few times in their lifetime, and certainly not at such speed. To determine whether the rewards are worth the cost, and whether there are other and better options for beneficial personal mobility, will require an engaged public debate.

**Dr Rachel Freeman is a research associate at the Tyndall Centre for Climate Change Research, University of Manchester, and is funded by the UK Energy Research Centre, under the research project RACER (Rapid Acceleration of Carbon Emissions Reductions from Cars).[13]**

# Update

In January 2018 the CCC published an assessment of the UK's Clean Growth Strategy.[14] The study found that by 2030 the largest sectoral policy gap, when forecast emissions assuming policies in the Clean Growth Strategy are compared with those required by CCC planning, will be in the transport sector. The policy gap stands at 42 MtCO2e in 2030, twice that of the power sector. The study confirms the need for much more concerted action in reducing transport emissions.

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