Life-cycle energy consumption and carbon dioxide emissions of world cars

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Almost 5,000 car models including over 8500 lb (GVWR) trucks, SUVs and pickups that are used "like a passenger car" were evaluated in terms of their life-cycle energy consumption and carbon dioxide emissions.

The tank-to-wheel fuel consumption (i.e. fuel economy) of an average car model was found to be 8.4 liters (diesel/petrol) per 100 km, which is equal to 30.3 miles per gallon (mpg). The carbon dioxide emissions of an average car model are 209 g/km. The curb weight of an average car model is 1488 kg. However, an average new light-duty vehicle (including cars, pickups, SUVs and vans) sold in EU-15+USA has a curb weight of 1534 kg, tank-to-wheel fuel consumption of 9.5 L/100 km (diesel vehicles 16.9%, petrol vehicles 83.1%) and tank-to-wheel carbon dioxide emissions of 230 g/km.

The tank-to-wheel fuel consumption is only part of the story. Petroleum and fuel transport and production consume energy, as well as car manufacturing and scrapping and the maintenance and infrastructure. The total energy consumption of car use is in average 54.7% higher than the tank-to-wheel energy consumption alone. In this study, tank-to-wheel fuel consumption and curb weight of a vehicle are the main parameters in assessing the life-cycle energy use of different car models.

The world consumes petroleum (crude oil) a bit over 80 million barrels per day (Mbpd). In 2005 EU-15 with a population of 379.84 million consumed 4.57 Mbpd petroleum for the light-duty car fleet, while USA with a population of 290.79 million consumed 11.15 Mbpd. The corresponding carbon dioxide emissions were 0.66 Gt and 1.60 Gt, respectively. Altogether EU-15 and USA consumed 15.72 Mbpd petroleum for the light-duty car fleet (well-to wheels consumption), and the corresponding carbon dioxide emissions were 2.27 Gt. In addition, about 3.42 million barrels per day petroleum equivalent primary energy (oil, coal, natural gas, hydroelectric power and nuclear power) was consumed for the rest of the vehicle life cycle.

On the top of the list (below) are the most ecological cars that consume least energy during the life cycle of the car. On the bottom of the list are the least ecological cars.

If we pick up the most ecological car, Citroen C1 1.4 HDi 55 3-door (diesel), and calculate the hypothetical situation where the current light-duty car fleet is suddenly substituted for this car model, the petroleum consumption would fall from 15.72 Mbpd down to 6.65 Mbpd in EU-15 and USA together. In addition, 1.94 million barrels per day petroleum equivalent primary energy (oil, coal, natural gas, hydroelectric power and nuclear power) would be consumed for the rest of the vehicle life cycle.

If we pick up the least ecological car, Hummer H1 Wagon (petrol), and calculate the hypothetical situation where the current light-duty car fleet is suddenly substituted for this car model, the petroleum consumption would go from 15.72 Mbpd up to 49.86 Mbpd in EU-15 and USA together. In addition, 9.34 million barrels per day petroleum equivalent primary energy (oil, coal, natural gas, hydroelectric power and nuclear power) would be consumed for the rest of the vehicle life cycle.

Altogether EU-15 and USA import petroleum more than 20 million barrels per day. By 2030, the consumption of oil in the world is projected to grow 50% to 120 million barrels per day and the number of cars will surge. On the other hand, some analysts and researchers have predicted that we may already have reached or will soon reach peak oil. Coal-to-liquids, gas-to-liquids and exploitation of tar sands are mature technologies and they will provide some petrol and diesel fuel in the future but at the cost of higher carbon dioxide emissions.

World desperately needs alternative – nonfossil – fuels, but no sustainable alternative fuel is at sight. The production of biofuels is unfortunately very energy intensive, far more energy – usually fossil – is needed to raise the crops and to produce biofuel out of them than the fuel gives when it burns. Lignocellulosic ethanol is maybe the most promising alternative fuel. However, calculations show (Klemola Kimmo, unpublished life-cycle analysis) that to replace all the EU-15 and US light-duty vehicle fleet to use cellulosic ethanol would require more than 4 billion hectares forest to be reserved for ethanol production, more than there are forests in the world. In addition, some fossil energy input would be needed.

Hydrogen is also not a solution. In principle, wind and solar energy could produce clean hydrogen for cars, but for the foreseeable future this energy should rather be used to replace electricity from coal-fired power plants.

We have just one solution and it is a simple one: we must cut consumption. This study can be used in selecting a more ecological car.

The basic data – curb weights and city/highway combined fuel consumption – are from multiple sources. There may be inaccuracies in the data.

EU-15 and USA together:
Average scrapping age is 14.97 years.
The driving distance of an average car is 16 761 km/year.
The whole lifetime driving distance of an average car is 250 919 km.
Total life-cycle energy consumption includes operation, manufacturing, maintenance, scrapping and infrastructure.
The most ecological car is on the top, and the least ecological on the bottom.

USA:

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - alphabetical order
United States:
Average scrapping age is 15.50 years.
The driving distance of an average car is 19 654 km/year.
The whole lifetime driving distance of an average car is 304 732 km.

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - energy consumption order
United States:
Average scrapping age is 15.50 years.
The driving distance of an average car is 19 654 km/year.
The whole lifetime driving distance of an average car is 304 732 km.

EU-15:

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - alphabetical order
EU-15:
Average scrapping age is 14.38 years.
The driving distance of an average car is 13 549 km/year.
The whole lifetime driving distance of an average car is 194 787 km.

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - energy consumption order
EU-15:
Average scrapping age is 14.38 years.
The driving distance of an average car is 13 549 km/year.
The whole lifetime driving distance of an average car is 194 787 km.

EU-15 and USA together:

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - alphabetical order
EU-15 and USA together:
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EU-15 and USA together:
Average scrapping age is 14.97 years.
The driving distance of an average car is 16 761 km/year.
The whole lifetime driving distance of an average car is 250 919 km.

Finland:

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - alphabetical order
Finland:
Average scrapping age is 14.38 years.
The driving distance of an average car is 13 549 km/year.
The whole lifetime driving distance of an average car is 298 581 km.

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - energy consumption order
Finland:
Average scrapping age is 14.38 years.
The driving distance of an average car is 13 549 km/year.
The whole lifetime driving distance of an average car is 298 581 km.

Sweden:

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - alphabetical order
Sweden:
Average scrapping age is 16.32 years.
The driving distance of an average car is 14 356 km/year.
The whole lifetime driving distance of an average car is 234 334 km.

Energy consumption and carbon dioxide emissions data for various car models (mostly 2006) - energy consumption order
Sweden:
Average scrapping age is 16.32 years.
The driving distance of an average car is 14 356 km/year.
The whole lifetime driving distance of an average car is 234 334 km.

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Effect of car scrapping age on various emissions (April 27 2006)

PS. To assess the impact of flying on the environment, please visit **www.dontfly.org**.

Citations to this study:

Klemola Kimmo, Life-cycle energy consumption and carbon dioxide emissions of world cars, http://www2.lut.fi/~kklemola/dontfly/carsof2006.htm, 2006.