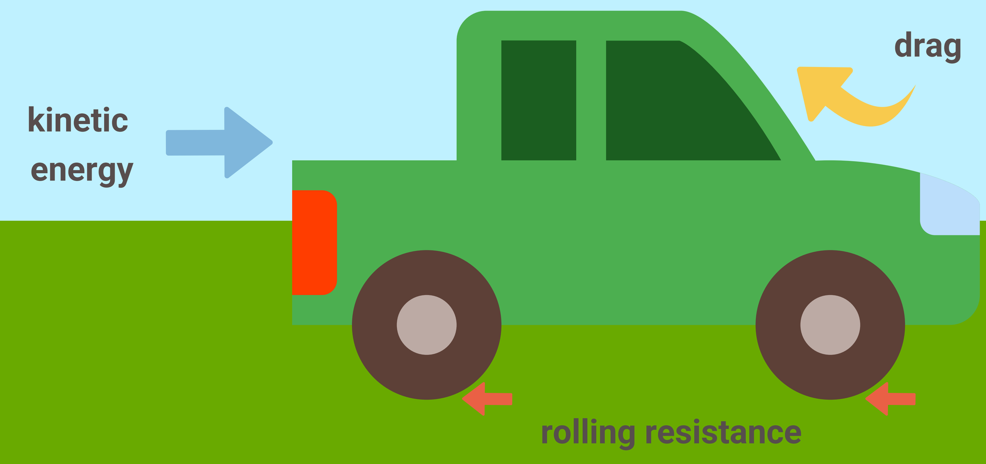
THE ENERGY OF TRANSPORT

WHY IT'S MORE THAN JUST THE ENGINE



There is more to sustainable transport than just electrification of engines. The weight, size, type of wheel and the speed we travel at all have a massive effect on energy consumption and CO2 emissions. Reducing the energy of our transport systems also comes with a host of other benefits such as less noise, fewer collisions, reduced air pollution and less damage to our roads.

THE 6 COMPONENTS OF VEHICLE ENERGY

FRONTAL AREA

m²

Air resistance makes up around 80% of the energy needed to keep a vehicle moving. The bigger the frontal area (A), the more energy is needed. Below are some examples of frontal areas in square metres (m2) for a train, a truck, an SUV and a small car.

11 | 10 | 3 | 1.5

COEFFICIENT OF DRAG

Even though a vehicle has a particular frontal area, the energy needed to move it through the air can be improved by reducing the coefficient of drag (Cd). Instead of having a flat front, a vehicle can have a sloped one, or a cyclist can wear tighter fitting clothes

0.8 | 0.2 | 0.6

WEIGHT

KG

Weight mainly influences the energy needed to accelerate and stop a vehicle. It also affects the rolling resistance. Below are the weights of a tram carriage, a typical SUV, the average EU weight car and a cyclist all with an average UK person (77 kg) in/on.

12,000 | 2,577 | 1,461 | 92

ROLLING RESISTANCE

Rolling resistance is the energy needed to roll a wheel. The wider and more squashy a tyre, the more energy needed to move it. The heavier a vehicle, the more it can squash a tyre increasing this energy. A hard train/tram wheel on a hard rail barely flexes.

0.01 – 0.02 | 0.001

ENGINE TYPE

%

The internal combustion engine is notoriously inefficient. A high performance petrol sports car engine can have an efficiency as low as 5%, where as a diesel engine on a motorway is more like 40%. An electric motor plugged into the mains is around 90% whereas battery losses make battery powered electric vehicles slightly less efficient. The human body is only around 25% efficient at converting food into movement.

0.05 – 0.4 | 0.7 | 0.9 | 0.25

SPEED

The energy needed to accelerate a vehicle to 40mph is 4 times that to accelerate it to 20mph. To keep a vehicle going at 40mph requires 8 times the energy needed to keep it going at 20mph.

20 | 30 | 70

9m/s | 13m/s | 31m/s

DENSITY OF AIR

= 1.3

GRAVITY

= 9.81

6 COMPONENTS COMBINED

DRAG ENERGY (J)

1/2 x m² x x x ³ /

KINETIC ENERGY (J)

1/2 x KG x ² /

ROLLING RESISTANCE (J)

1/2 x x KG x /

CO_2 EMISSIONS OF FUEL

1 Joule = 0.06mg | 0.09mg | 0.3mg

OTHER BENEFITS OF REDUCED ENERGY

ROAD DAMAGE

The 4th Power Law estimates that an SUV does 50,000 times the damage of a cyclist. This also affects generation of particulates. Plastic from car tyres is the main source of microplastic pollution.

LESS NOISE

A car traveling at 20mph emits around half the noise of a car at 30mph. Electric vehicles are much quieter than petrol and diesel because there is less wasted energy.

CLEANER AIR

Whilst NOx emissions from combustion engines depend heavily on exhaust systems, CO2 and non-exhaust emissions are directly related to energy.

FEWER INJURIES

A small car at 30mph has double the energy of one traveling at 20mph. An SUV driving at 30mph has 80 times the energy of a moped rider doing the same speed.