Summary

Emissions of CO_2 and atmospheric pollutants from road transport can be considerably reduced by 2050 using currently known technologies, while at the same time making road transport much less dependent on oil. A 60 to 80 per cent reduction in CO_2 emissions from 1990 levels is possible. Emissions of atmospheric pollutants (NO_x, PM_{10}) are already being considerably reduced by current policies, but further reductions are possible. The main options for doing this are the introduction of alternative vehicle types, such as electric and fuel cell vehicles, and energy carriers that generate little CO_2 and atmospheric pollution, such as electricity and hydrogen. Another way to reduce emissions is to curb the demand for mobility. Possibilities include better freight transport logistics, a higher price per kilometre travelled by road transport, switching from road transport to other means of transport (modal shift) and more home working. At the same time, this will improve traffic flows and road safety.

Alternative vehicle types, low-emission energy and a lower demand for mobility will not come automatically. Government intervention will be needed. In any case, alternative vehicle and energy carrier technologies will have to undergo considerable further development to reduce costs. But even if costs are significantly reduced, these technologies may remain more expensive than the current more polluting technologies. However, if low-emission technologies are to be widely adopted, they must be competitive with the (cheaper) more polluting technologies. This is feasible if the government pursues an emissions reduction policy, for example by setting standards or through emissions pricing. This would allow market participants to make their own technological choices, which is sensible because at the moment we do not know which low-emission techniques will prove to be most cost-effective and enjoy broad public support. The long development and lead times of low-emission technologies mean that policy instruments must be put in place quickly if major emissions reductions are to be achieved by 2050.

The Ministry of Infrastructure and the Environment asked the Netherlands Institute for Transport Policy Analysis (KiM) to investigate concrete options for ensuring that by 2050 road transport emissions of greenhouse gases (CO_2) and atmospheric pollutants (NO_x and PM_{10}, or fine particulates) are considerably lower and road transport is much less dependent on oil. A second question concerns the conditions needed to achieve this and the effects on road safety and traffic flows. For CO_2, a target was chosen of a 60 to 80 per cent emissions reduction in 2050 compared with 1990. The Climate and Air Quality Department of the Directorate-General for the Environment will use the results of this study in the preparation of a ‘Climate 2050 Roadmap’ for achieving the CO_2 emissions reduction by 2050 and any follow-up actions.

KiM carried out this study through a combination of a quick scan of the existing literature, interviews with research institutes and its own analysis. Given the distant time horizon and the uncertainties that go with this, we looked at the order of

magnitude of emissions reductions and the costs involved, and at the global effects on traffic flows and road safety. The effects were compared with a reference situation: an estimate of the situation in 2050 based on a continuation of current policies and existing trends.

Four strategies

Most CO_2, NO_x and PM_{10} emissions have a common origin. All three are combustion emissions and arise from the combustion of oil (or other fuels). This means that there are many opportunities to reduce these emissions and oil dependence at the same time. We identified four possible strategies for doing this:

1. KILOMETRES: reducing the number of kilometres travelled. The options are home working, electronic shopping and conferencing (facilitated by the use of ICT), a shift from road vehicles to other forms of transport (modal shift), improved freight transport logistics, compact cities and a higher price per kilometre travelled.
2. VEHICLE: modifying vehicles and adjusting speeds to make driving more energy efficient. The options are fuel-efficient engines, lightweight and smart vehicles, low-emission driving speeds, and electric and fuel cell vehicles.
3. ENERGY: using alternative energy carriers that cause fewer emissions per unit of energy consumed by the vehicle as alternatives to petrol and diesel. Options are biofuels and low-emission electricity and hydrogen.
4. FILTER: filtering or cleaning vehicle exhaust gases to prevent them entering the environment (end-of-pipe). Options are particulate filters, catalytic converters and exhaust gas recirculation.

The first strategy is non-technical, although technology can play a facilitating role. The second, third and fourth strategies are mainly technical in nature.

Using alternative energy carriers offers the best prospects

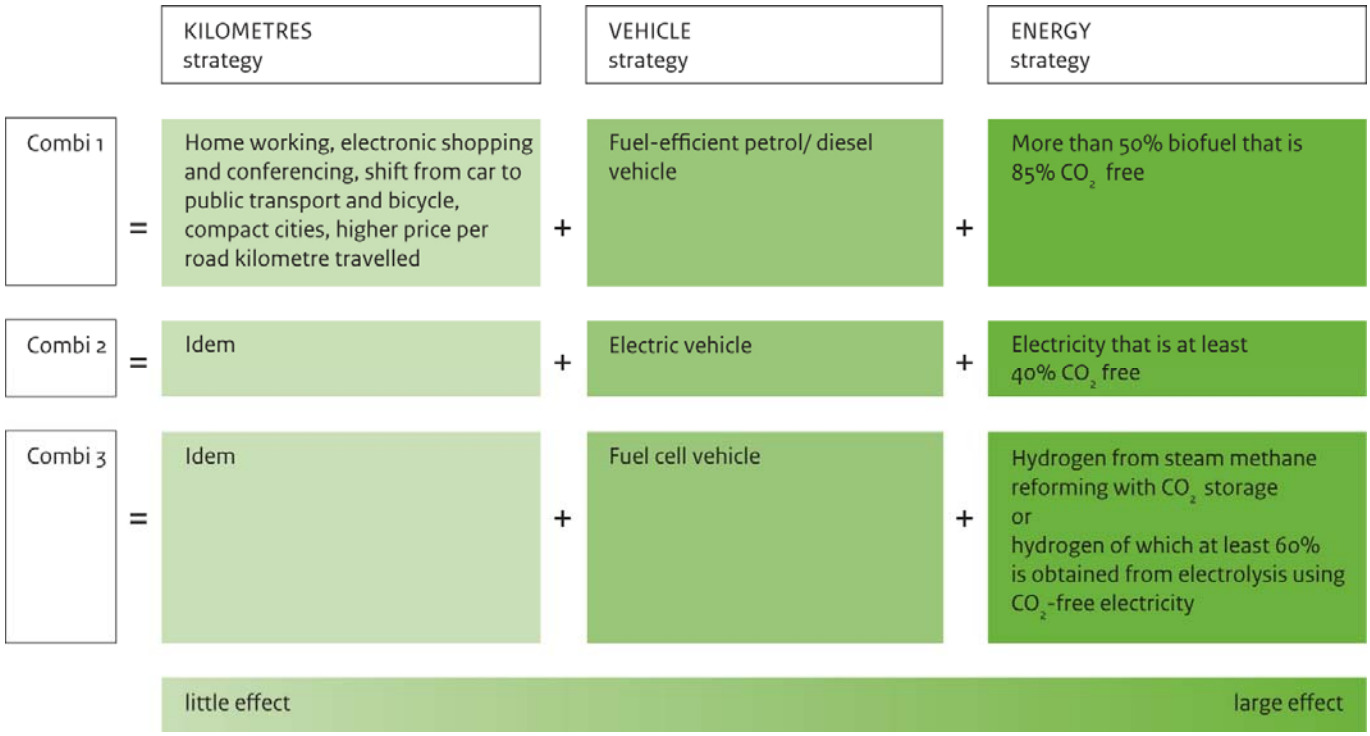
The study resulted in the following findings:

- Alternative energy carriers offer the most possibilities for reducing emissions and oil dependency, followed by more energy-efficient driving by modifying vehicles and adjusting driving speeds. Reducing the number of kilometres travelled offers the least prospect of reducing emissions.
- There are many methods of cleaning or filtering vehicle exhaust gases that reduce emissions of NO_x and PM_{10}. The options we found in the literature are already the subject of current policy and so any additional emissions reductions would be limited.
- Reducing the number of kilometres travelled, and to a lesser extent adjusting driving speeds, can have a positive effect on traffic flows and road safety; introducing alternative energy carriers and cleaning exhaust gases have no influence on this.
- In all the strategies, the potential for reducing emissions and dependence on oil are greater or much greater for private cars than for goods vehicles. This is because electric and fuel cell vehicles are less suitable for goods transport. This therefore also excludes the possibility of using low-emission electricity and low-emission hydrogen as energy carriers, which offer considerable prospects for reducing emissions and oil dependence.

Reducing CO_2 emissions by 60 to 80 per cent from 1990 levels is theoretically achievable

For private cars it is potentially possible to meet the 60 to 80 per cent CO_2 emissions reduction target by 2050 with each of the following combinations of options from the KILOMETRES, VEHICLE and ENERGY strategies:

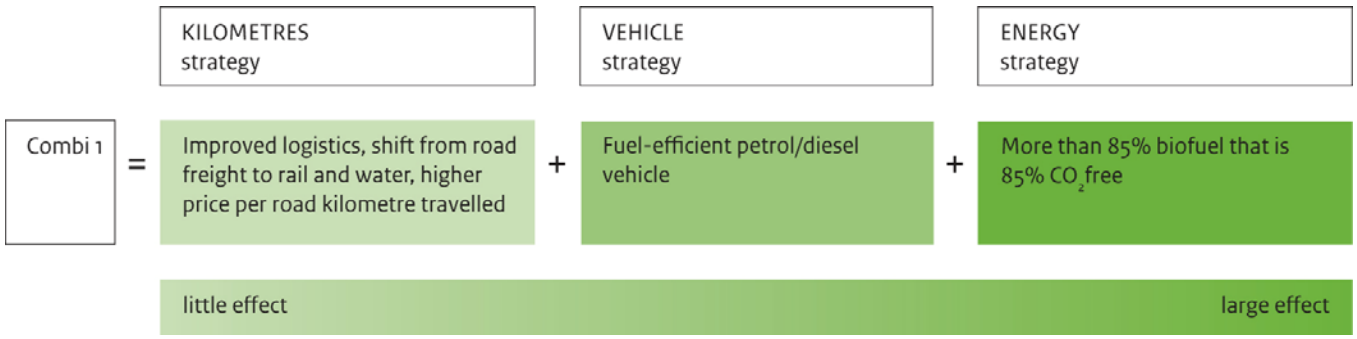
Figure S.1
Combinations of options for private cars with which the CO_2 target of a 60–80% emissions reduction by 2050 can be met



The CO_2 target can also be achieved without using the KILOMETRES strategy as long as the percentages in the last column are raised by a few percentage points.

For goods vehicles, the CO_2 target of a 60–80% emissions reduction by 2050 is in theory achievable with the following combination:

Figure S.2
Combination of options for goods vehicles with which the CO_2 target of a 60–80% emissions reduction by 2050 can be met



The CO_2 target for goods vehicles can be achieved without making use of the KILOMETRE strategy if all fuel used consists of 100% biofuel.

Costs and public support are potential obstacles
The main constraints and obstacles to realising the potential of the four strategies are:

- Higher costs: Low-emission road transport in 2050 will be more expensive than road transport in the reference situation. The alternative vehicles and energy carriers are more expensive than conventional petrol and diesel vehicles, which are the products of a long period of development. This difference in cost may remain in future. The options for reducing the number of kilometres travelled, such as a modal shift and compact cities, may also be more expensive.
- Uncertainties about technological developments: Reducing the current high costs of low-emission vehicles and energy carriers will require considerable technological advances. It is not certain that these will occur. A chicken and egg situation could arise in which costs will only fall when there is a large market for the technology (in other words, through economies of scale).
- Lack of public support. In themselves, the alternative vehicles and energy carriers deliver no added value to users over traditional petrol or diesel vehicles, and sometimes even a decline in comfort. The options for reducing the number of kilometres travelled are also generally not very popular.
- A possible constraint on the use of biofuels is the limited availability of biomass. Biomass production for the manufacture of biofuels competes with other crops for land, nutrients and water, and the use of biomass as a source of energy involves competition between sectors.

What is needed to realise the theoretical possibilities?
Sustainable road transport will not come about by itself. An essential condition for achieving a major reduction in road traffic emissions is a significant level of government intervention. Large number of actors will have to be mobilised. For the development of low-emission technologies, these will mainly be from the automobile industry and the energy sector. A scarcity of oil is not expected to be

the main driver of emissions reduction: many unconventional sources of oil are available, such as oil from natural gas or coal, and these will become economic as oil prices rise. It is therefore by no means obvious that as conventional oil reserves become depleted a transition will be made to sustainable, low-emission energy carriers.

At the moment it is not yet clear which low-emission technologies will eventually ‘win’, in other words which ones will perform best on costs and public acceptance. There may be no outright winner, with each technology having its own specific area of application. It would therefore be sensible for the government to keep all the available technological options open. If low-emission technologies are to be introduced on a large scale, they must be able to compete with (probably cheaper) polluting technologies, such as conventional petrol and diesel vehicles. This is feasible if the government pursues a low emissions policy, for example by setting emission standards or through emissions pricing. This would keep all the options open: the government would not be making any technological choices and market participants would choose the technology that is most economical or advantageous to them. Because of the uncertainties about whether low-emission technologies will become mature enough for widespread use, it is sensible also to pursue the option of reducing demand for mobility (driving less).

Policy measures should be put in place quickly because it will be a long time before new technologies or options for reducing the number of kilometres travelled are mature enough to be implemented on a large scale. This will involve a fundamental change from the present situation, which cannot be effected quickly. The most appropriate scale for developing new types of vehicle and low-emission energy carriers is Europe-wide, and so policies will be needed at the European level. For reducing the number of kilometres travelled, policies at the national and regional scales are the obvious choice.