Summary

The Ministry of Infrastructure and the Environment wants to reduce CO_2 emissions from Dutch road transport by 60% from the 1990 level by 2050. This presents a considerable challenge. The market (consumers, industry) will not bring about this reduction 'by itself'; policy measures will be needed to remove or reduce the existing obstacles. A major obstacle is the fact that emissions have no price in the market. Another obstacle is that new vehicle and fuel concepts with much potential for reducing emissions are not yet full substitutes for current vehicles and fossil fuels. Developing new knowledge and technologies also poses problems.

To overcome these difficulties effectively and efficiently, government policies must pursue two strategies. The first focuses on implementing reduction options that are already well developed and almost suitable for introduction into the mass market. These will make it possible to achieve *direct* emissions reductions. The second strategy focuses on innovation, in which potentially promising reduction options that are not yet suitable for introduction into the mass market are further developed and their price/performance ratio improved. The aim is to develop options for efficient emissions reductions *in the future*. Various policy options are available for each of these strategies. For example, possible policy options for the first strategy include setting emission standards and establishing an emissions trading scheme for road transport emissions. Policy options for the second strategy include specific R&D subsidies and announcing a tightening of emission standards in the future. Some policy options are within the domain of national government, while others would be within the remit of the EU or regional and local government.

Ambitions for sustainable road transport

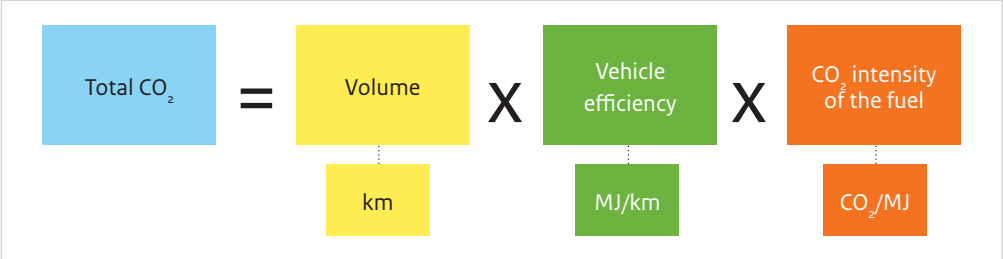
The Ministry of Infrastructure and the Environment wants to establish which policy options can be used to reduce CO_2 emissions from Dutch road transport by 60% from the 1990 level by 2050. CO_2 emissions from road transport are now a third higher than they were in 1990. Reducing CO_2 emissions from road transport is part of the ministry's broader policies for sustainable mobility.

In 2011 the Netherlands Institute for Transport Policy Analysis (KiM) carried out research into the *reduction options*, the physical possibilities, for achieving major reductions in emissions from road transport, especially from private cars and goods vehicles. This present study is a follow-up to the previous research and examines the *policy options* available to the government and other authorities (EU, regional/local) for making real reductions in CO_2 emissions. An important assumption is that the market (consumers, industry) will not take up these options on its own, because various *obstacles* stand in their way. Government can remove or reduce these obstacles by introducing policy measures.

Options for achieving a 60% emissions reduction by 2050

The physical possibilities for reducing road transport emissions by 60% in the period to 2050 can be divided into three categories, which together determine CO_2 emissions from road transport (see Figure S.1). These categories can be thought of as 'levers' which can be pulled to influence CO_2 emissions. This 60% reduction target concerns only the emissions from the vehicles themselves, the 'tank-to-wheel emissions'. Emissions from the extraction, production and distribution of energy carriers for road transport, the 'well-to-tank emissions', are usually not included in road transport emissions, but are allocated to other sectors, such as industry and electricity generation. For this reason, the CO_2 intensity of the fuels here relates only to the CO_2 emissions from the vehicles themselves.

Figure S.1 Three levers for reducing CO_2 emissions from road transport



The reduction options with (as far as we know) the greatest potential for achieving the 60% reduction target for road transport emissions are in the categories 'vehicle efficiency' and 'CO_2 intensity of the fuel'. These include options like electric vehicles and fuel cell vehicles, the use of advanced biofuels and making internal combustion (IC) engine vehicles much more efficient. These reduction options are not yet ripe for large-scale rollout in the national vehicle fleet, but are in various stages of development, varying from the 'R&D stage' for highly efficient IC engine vehicles and advanced biofuels to the 'prototype stage' for fuel cell vehicles and 'niche market applications' for electric vehicles. Efficient reduction of road transport emissions will first require further innovations in these reduction options, especially to considerably improve their price/quality ratios. In addition, an alternative charging/filling infrastructure is an essential requirement for the large-scale rollout of electric and fuel cell vehicles.

Combining these options with volume reduction measures (including a shift to other transport modes, such as public transport and bicycles) can reduce the total number of vehicles needed (conventional or alternative), because the national fleet will grow less quickly or be reduced in size, as well as reduce the amounts of electricity/hydrogen/biofuels needed, because fewer kilometres will be travelled in total. This volume reduction also brings additional benefits for land use and accessibility.

There are also reduction options that are already ripe for market introduction, such as cars with slightly more efficient IC engines, fuel-efficient tyres, driving at slower speeds, etc., but these options have a smaller reduction potential; on their own these will not be enough to meet the 2050 target.

Obstacles hold up implementation of the reduction options

The reduction options that are not yet ripe for market introduction, but which hold great potential for reducing emissions, are being held up by obstacles to innovation and diffusion. Such obstacles always arise when new technologies threaten to break the hegemony of existing technologies (in this case the state-of-the-art IC engine and fossil fuels), but they present even greater obstacles than usual to new technologies designed to reduce emissions. This is because reducing emissions is mainly of value to society as a whole, but often is of little or no direct interest or benefit to the individual transport user,

examples being the use of biofuels and electric cars (long charging times and range anxiety). This is what distinguishes various reduction options for road transport from new technologies that do offer benefits to individual users, such as mobile telephones and airbags.

An incremental 60% emissions reduction by combining the two strategies

The policy ambition of reducing CO_2 emissions from road transport by 60% from the 1990 level by 2050 can be achieved efficiently by pursuing policies based on two strategies:

- Emissions reduction: a focus on *direct* emissions reduction.
- Innovation: a focus on innovation, especially to improve the price/quality ratio, in reduction options that hold promise but which are not yet suitable for the mass market. The goal is to make these reduction options suitable for efficient emissions reduction *in future*.

Combining both strategies will bring the 60% emissions reduction target within reach *incrementally* and efficiently. Under the emissions reduction strategy, efforts will be made immediately for the dissemination of reduction options that are market ready. In the first instance, this will deliver a relatively small reduction in emissions in relation to the target. At the same time, the innovation strategy will ensure that potentially effective reduction options that are not yet ready for market introduction are developed as quickly as possible, especially to improve their price/quality ratios. These reduction options can then be rolled out on a large scale at a later stage – bringing about a major reduction in emissions – under policies for the emissions reduction strategy.

The choice of specific policy options for each of the strategies will be based mainly on political and administrative considerations, depending on preferences and 'span of control' (for example, vehicle standards and quality standards for biofuels can only be set at the EU level). Many policy options for CO_2 reduction in road transport can only be pursued at the European level because the EU is often the relevant competent authority and because of the political and administrative desire to create and maintain a European level playing field. National, regional and local governments often have a more facilitating role, for example by providing subsidies for R&D and subsequent rollout of new technologies, issuing permits, making agreements with market actors, etc. The question of whether other interests than making road transport more sustainable are involved, such as an 'earning potential' for the Dutch economy, may also be a consideration when deciding on specific policy options.

Emissions reduction strategy: focus on direct CO_2 reduction

The effects of policy options in this strategy are measurable in tonnes of CO_2. The options are geared especially to addressing the problem of the lack of a price for CO_2 in the market and the short payback times observed by both companies and consumers: they prefer vehicles that are cheaper to buy, but more expensive to run, rather than vehicles that are more expensive to buy, but which are cheaper to run. This puts energy-efficient vehicles at a disadvantage compared with less efficient vehicles, which is undesirable from the point of view of society as a whole.

Examples of policies for this strategy are:

- the (gradual) tightening of vehicle and fuel standards;
- emissions trading (with a gradual lowering of the emissions cap);
- emission taxes and fuel duties;
- voluntary agreements with companies on emissions reductions (covenants);
- investments in bicycle and public transport infrastructure.

Each instrument has its own profile regarding certainty of effect, efficiency, market choice, 'span of control' for the Netherlands and transaction costs (the costs of the policy intervention itself). Instruments which are directed simultaneously at volume, vehicle efficiency and fuel choice, such as emissions trading and emission taxes, in principle give the market the greatest freedom to adopt the cheapest reduction options first, which leads to cost efficiency.

Focusing on volume reduction in specific market segments – such as a shift from the car to public transport, bicycle or electric bicycle, higher load factors in freight transport, greater use of car shares, etc. – is relatively difficult in relation to the emissions reductions which can be achieved by such measures. The emissions reduction potential can often only be achieved by major policy interventions and/or at high cost, without any prospect of significant improvement in future. There are various reasons for this, such as:

- The bicycle is already a widely used form of transport in the Netherlands and increasing bicycle use would require a major (and expensive) increase in the quality of the cycle infrastructure.
- For many trips, public transport is not a suitable alternative to the car, and rail and inland shipping are not a suitable alternative to the lorry.
- A higher load factor for goods vehicles goes against current trends.

It may be better to stimulate these routes to volume reduction as part of a wider set of policies with objectives like congestion reduction, traffic safety and social accessibility, and not just as a means to reduce CO_2 emissions.

Innovation strategy: focus on enabling efficient emissions reductions in future

The effects of policy options in this strategy are less measurable; the policy outcomes cannot be measured in tonnes of CO_2. Their goal is to facilitate and speed up the innovation process for promising reduction options that are not yet ready for introduction into the market, primarily to obtain considerable improvements in the price/quality ratios of these reduction options. The aim is efficient emissions reduction *in the future*. Policy options in this strategy are directed at the tendency of companies to 'underproduce' knowledge and exchange less knowledge than is desirable for society as a whole. They are unable to recoup all or some of the costs of obtaining this knowledge and face a big risk that other parties will be able to profit from the knowledge they have generated. This knowledge may be in the form of learning by research (R&D), learning by doing (testing prototypes) and learning by using (use in niche markets).

Examples of policies for this strategy are:

- specific subsidies for R&D in clean technologies;
- announcing future tightening of taxes/standards/emission caps so that knowledge-creating companies know that in future there will be a market for innovative products;
- subsidies and/or temporary fiscal benefits for product development and rollout in niche markets;
- improving legal and other conditions necessary for large-scale implementation in future;
- the government as launching customer.

Policies in this strategy are tuned to the needs of the developmental stage where promising reduction options can be found (R&D, prototype, first introduction into niche markets). A justification for targeted R&D subsidies for clean technology instead of generic stimulation of all R&D is that new knowledge tends to be built on the foundations of existing knowledge, which gives polluting technologies a head start on clean technologies. Without government intervention there is a risk that this advantage will be perpetuated or even become bigger.