A Different Way of Paying for Road Use

Impacts on traffic, environment & safety, technology, organisation, enforcement and costs

Management summaries

Ministry of Transport, Public Works
and Water Management

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A Different Way of Paying for Road Use

Impacts of Policy Options on Traffic

29 March 2005

Management Summary

The reason for this report
The Dutch Minister of Transport, Public Works and Water Management and the Dutch Minister of Finance has asked the platform on 'A Different Way of Paying for Road Use', led by Mr Paul Nouwen, for a considered opinion on pricing policy that can receive broad public support.

The platform asked the AVV (Transport Research Centre), the CPB (Central Planning Bureau) and the MNP (Environment and Nature Planning Bureau) to assess the traffic impacts of ten different forms of pricing policy. The platform will base its opinion, among other things, on these impacts.

The significance of traffic impacts
The AVV and CPB studied most of the ten pricing policy options using the AVV's National Model System. Additional analysis was carried out using the New Regional Model to understand specific regional aspects. Also a meeting was held with transport experts, during which results were assessed and the qualitative effects of options not analysed using models were estimated.

Findings concerning the traffic impacts are important because the results of this study will be used for various subsequent studies:
- Impacts on households (CE)
- Impacts on business (ECORYS)
- Impacts on the composition of the car fleet and the environment (NMP)
- Impacts on different income groups (CPB)
- Economic valuation of impacts on locational accessibility (CPB).

The ten policy options in this study were compared with each other and also with a situation without a pricing policy. This reference situation or starting situation is the same for each option. The same evaluation year as the one used in the *Mobility Policy Document* – 2020 – was chosen. The scenario used in this study is 'European Co-ordination', developed by the CPB. Transport policy has been specified until 2011. For a realistic estimate of the effects of the policy options on the subsequent period, implementation of the road-building package described in the *Mobility Policy Document – part 1* has been assumed, estimated at € 14.5 billion.

No pricing policy leads to worsening locational accessibility
The table below indicates the effect of implementing the road-building package on road traffic trends in the 2000-2020 period, assuming a business-as-usual situation, i.e., without a pricing policy.

Traffic growth projections with business-as-usual scenario, 2000-2020 and impact of road-building package of € 14.5 billion on these									
	Traffic growth			Congestion					
	Neth.	Randstad	Rest of Neth.	Netherlands		Randstad		Rest of Netherlands	
				main roads	other roads	main	other	main	other
Traffic growth projections with business-as-usual scenario, 2000 - 2020.	+50%	+44%	+54%	+101%	+182%	+80%	+172%	+191%	+199%
Trends between 2000-2020, with road-building package of € 14.5 billion	+53%	+52%	+54%	+42%	+188%	+16%	+173%	+154%	+216%
Impact of road-building package on traffic volumes in 2020	+2%	+6%	0%	-29%	+2%	-35%	0%	-13%	+6%

In the business-as-usual situation, road traffic grows by 50% in the Netherlands. There will be twice as much congestion on the main road network in 2020 compared to the situation in 2000. The growth in congestion is even greater on other roads, partly because various plans concerning the secondary road network are either not known, or not yet known, and could therefore not be incorporated in the analyses. In the rest of the country, the expected growth in congestion is greater than in the Randstad. Here congestion is defined as the sum of all lost travel time as a result of recurring traffic jams. Nonrecurring traffic jams caused by accidents, etc., are not included.

The road-building package of € 14.5 million results in an additional increase in road traffic in the Netherlands of 2% compared to the business-as-usual situation, as road building creates more road space for car travel. Owing to the road-building package, congestion growth on the main road network is mitigated by about 30%. Congestion does increase compared to 2000, but to a lesser degree. The road-building package mostly concerns the Randstad and the main road network, which is where the mitigation of congestion growth primarily occurs.

Overview of impacts on traffic of pricing policy options for 'A Different Way of Paying for Road Use'									
Policy option		**Sub-option**	**Congestion reduction compared to reference situation in 2020**						**Notes**
			Netherlands		Randstad		Rest of Netherlands		
			main	other	main	other	main	other	
1	Kilometre charge	A) MRB (fixed motor vehicle tax) + ¼ BPM (purchase tax on motor vehicle)	-30%	-30%	-25%	-30%	-30%	-30%	Variabilisation of € 3.4 billion of fixed charges into differentiated amount per km in all of the Netherlands, main and secundary road networks
		B) MRB + BPM	-40%	-40%	-40%	-40%	-40%	-40%	Variabilisation of € 5.7 billion of fixed charges into differentiated amount per km .
2	Hofstra charge		-35%	-40%	-35%	-40%	-40%	-40%	Variabilisation of € 5.7 billion of fixed charges into differentiated amount per km in three brackets .
3	Kilometre charge, heavy goods		Raising average speed by 0.4%						Charge on main road network only, for trucks > 12 tonnes only Resembles German *Maut*
4	Toll at six locations		-15%	0%	-25%	0%	0%	+5%	Toll at six locations on main road network, as mentioned in *Mobility Policy Document - part 1*; effect of toll and infrastructure
5	Kilometre charge + congestion charge		-60%	-40%	-60%	-40%	-60%	-45%	Variabilisation of € 3.4 billion as in 1A plus static congestion charge of € 0.11/km
6	Entry charge in the four major cities	A static, not budget-neutral	-25%	-10%	-35%	-15%	0%	0%	Cordon-based charge in Amsterdam, Rotterdam, The Hague and Utrecht, € 2.90 into city, morning rush hour
		B after charge avoidance, not budget-neutral							Ditto, charging rate depends on level of traffic (between € 1.50 and € 6.00)
7	Area-wide charge in the four major cities		0%	-5%	0%	-5%	0%	0%	Area-wide charge in centres of Amsterdam, Rotterdam, The Hague and Utrecht within city ring roads, € 7.50/day, 90% discount for residents
8	Charge on congested corridors	A static	-50%	-20%	-50%	-15%	-50%	-20%	Congestion surcharge of € 0.11/km at busy locations (flow to capacity ratio > 0.8) in reference situation
		B after charge avoidance	-55%	-35%	-60%	-35%	-45%	-40%	Congestion surcharge of € 0.055-0.22/km, depending on charge avoidance behaviour
9	Charge through fuel duty		-15%	-15%	-15%	-15%	-20%	-15%	Variabilisation of € 3.4 billion of fixed charges into higher fuel duties
10	Tax increase to finance ambitions of *Mobility Policy Document*		-30%	-5%	-25%	-5%	-35%	-5%	Fuel duty increase of € 0.06 per litre, including creation of road-building package, as described in *Mobility Policy Document*

The effects of paying more per kilometre
Policy options involving paying per kilometre, i.e., options 1 (kilometre charge), 2 (Hofstra charge) and 9 (Charge through fuel duty), mitigate the growth of car travel. With these options, average travel distances decrease, both as regards commuter and leisure travel. Over time, the increase in variable car costs leads motorists to seek work and leisure activities closer to home. The number of car journeys declines slightly. More kilometres are travelled with other means of transport, primarily through the use of slow transport modes and rail. This increase depends on the level of the charge and reaches a maximum of 8% (in option 1b: MRB + BPM[1]).

The calculations include the current progressive tax rates: the heavier the car, the higher the rate per kilometre, as is currently the case with the MRB. Accordingly, no effects on the composition of the vehicle fleet are expected. In option 2 (Hofstra charge), the rates are only progressive to a limited extent. This means that it can be expected that the Hofstra charge will have an effect on the composition of the fleet: the share of heavy cars and diesel cars will increase. Because corrections have not been applied to the calculations, the effect of the Hofstra charge may be slightly overestimated.

The slower growth in car travel in the 'kilometre charge' option means that the growth in congestion is mitigated. Business traffic grows more because of increased locational accessibility. The level of the charge determines the extent of the effects. This relationship, however, is not linear: the higher the charge, the smaller the additional decrease in road travel growth.

Compared to the 'kilometre charge', a charge collected through a fuel duty increase leads to more efficient use of fuel and an increase in the use of petrol stations outside the Netherlands. This means that in the event of a duty increase, the expected effects are smaller than with the Hofstra charge and 'kilometre charge'.

The response of goods traffic to a price incentive
Goods traffic is relatively unaffected by the kilometre charge. The value of the load and the costs of the truck and driver are many times greater than the charge introduced in option 3. This option slightly encourages improved efficiency in goods traffic:
- More efficient use of the vehicles' load capacity
- Use of larger vehicles in road transport
- Transport moving from the main road network to the secondary (regional) road network.

Owing to these improvements in efficiency, the cost increase for road hauliers is smaller than the increase in costs per kilometre as a result of the charge. Road haulers will attempt to pass this cost increase on to shippers, resulting in:
- a general decrease in demand for goods transport,
- a shift from road transport to other modes or to other countries.

[1] MRB: (fixed) motor vehicle tax. BPM: purchase tax on motor vehicles.

The result is a new modal split for goods transport in 2020. About 27.5 million tonnes less are transported by road. This corresponds to a decrease in the number of road freight vehicle-kilometres of 3.1%. This means a decrease of about 0.6% of total traffic. The effect of this on average speed in 2020 is an increase of 0.4%, based on analyses for the other options.

Goods transport by inland navigation and rail increases by 15.6% (additional shipping kilometres) and 6.1% (additional railway kilometres) respectively over the reference situation.

Paying more on busy roads
Applying a congestion charge (option 8, Charge on congested corridors) initially leads to traffic diverting onto roads without a congestion charge. Because the reference situation involves a high level of congestion, this charge will be applied on many stretches of road (both in main and secondary networks) in the Netherlands. This means that avoiding the congestion charge by taking other routes will not be possible for everyone at all times. As with the 'kilometre charge', a congestion charge will therefore result in an increased cost of motoring and shorter commuting distances. The difference here is that commuter traffic will be the most affected, as the congestion charge is limited to peak times. There is little leisure travel at rush hour as it is.

Because the charge applies only where there is congestion, the impact on congestion is greater than with the 'kilometre charge'. The design of the charging system is important here. A 'learning system' that takes into account road users' charge avoiding behaviour and also applies differentiated rates in different places has a greater impact on congestion and a lesser impact on car travel.

Increased locational accessibility thanks to a congestion charge means that business traffic increases even more than with the 'kilometre charge'.

According to transport experts, a more dynamic form of congestion charging only makes sense if motorists can still modify their behaviour. Motorists must have timely information on which to base their choice to drive or not to drive, to leave at a different time, etc. A situation with complete real-time changes in charging rates, based on current traffic volumes, would therefore have less of an effect than a situation in which the level of charge is known in advance.

The combination of a 'kilometre charge' and 'Congestion charge', in option 5, is the most effective method to combat congestion.

Some regional consequences of pricing policy
Entry charge in the four major
The entry charge works as follows: on passing a toll gate, every motorist must pay a toll. The 'payment points' can be found on both the main and secondary road networks, so that the charge cannot be avoided by rerouting. The tollgates are within the municipal boundaries of Amsterdam, Rotterdam, the Hague and Utrecht. The charge of € 2.90 applies only during the morning rush hour when driving into the city.

An analysis of the primary effects has been carried out; no allowance has been made yet for additional revenue from the charge being allotted to additional infrastructure, public transport facilities, facilities for slow traffic, etc.

Locally, congestion can decrease considerably because there is much less criss-cross traffic (for example, working in Amsterdam and living in Arnhem and vice versa). In the Randstad, congestion growth on the main road network is 35% less, and on other roads 15% less. There is no additional traffic diversion because the charge applies to the secondary road network as well. The impact on congestion is mainly limited to the four cities and their immediate vicinity: in the rest of the Netherlands, the charge has no noticeable effect. According to the experts, the rate at rush hour should be raised gradually in order to prevent unwanted road safety risks (such as waiting on the shoulder until after 9 am).

Area-wide congestion charge in the four major cities
This resembles the charge introduced in London in 2003. Within the city ring roads of Amsterdam, Rotterdam, the Hague and Utrecht, motorists have to pay € 7.50 each working day. Residents receive a 90% discount in their own city. The parking policy implemented in the reference situation stays the same.

For this policy option as well, only an analysis of the primary effects has been carried out, so the allocation of additional revenue obtained from the charge to projects such as additional infrastructure has not been taken into account either.

The mitigation of congestion growth in the Randstad (-5%) is caused by improved flows on the ring roads of the four major cities. The charge has no effect on congestion on the main road network. The destinations of much of the traffic on the main road network are apparently not the city centres, so the charge has no effect on traffic on the main road network. Many car journeys destinations, such as Schiphol airport and peripheral business premises, are not within city ring roads either. In this policy option, internal city traffic continues to use the city ring roads.
According to the transport experts, the city ring roads should be included in the charging zone if the goal is to reduce congestion on city ring roads as well.

It is expected that the actual impacts of pricing policy may be less substantial than analyses indicate. The most significant causes of this are:
- doubts about the emergence of a 24-hour economy, so that much less commuting to work occurs at unexpected times;
- doubts whether employers are willing to compensate employees for the charges;
- less willingness to move house than anticipated.

Highway tolls
Tolls are a means of financing or co-financing infrastructure. This form of pricing also affects road travel and congestion. The effect of tolls on six new stretches of road to be built as part of the main road network has

been studied, using a charging rate of € 1 per trip for passenger cars and € 3 for trucks.

The analysis takes into account potential unwanted traffic diversion onto other routes, which can be prevented by charging a toll on alternative routes as well. This policy option reduces congestion by 15% on the main road network. In the Randstad, where most of the tolled roads are located, congestion decreases by 25%. Most of this decrease is because traffic is eliminated or diverted onto other roads and to a lesser degree because additional infrastructure becomes available.

What happens to the revenues?
In some policy options, the state receives additional revenue from the charges that is not redirected to citizens through the elimination of fixed taxes such as the MRB (motor vehicle tax) and the BPM (purchase tax on passenger cars and motorcycles).

This additional revenue could be spent on additional infrastructure to eliminate other bottlenecks, thereby mitigating congestion growth even more. As regards these policy options, the effect on congestion of the road-building budget that is made available has been worked out, as shown in the following table.

Policy options	Road-building budget (€ billions)	Congestion reduction through additional infrastructure (compared to 2020 reference)
5. Kilometre charge + congestion charge	2.5	-3.3%
6. Entry charge in the four major cities	2.3	-3.1%
8a. Static congestion charge	5.8	-7.6%
8b. Dynamic congestion charge	7.5	-9.8%

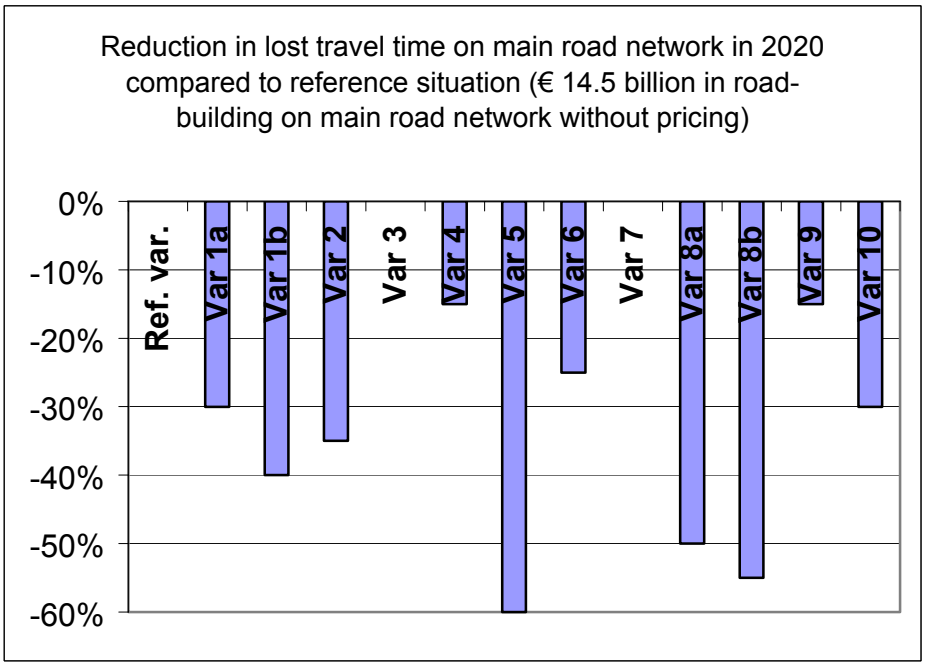
Road-building budget based on CPB calculations

The largest additional budget is provided by the congestion charge, which also mitigates congestion growth.

Conclusions

- Pricing policy leads people to change their travel behaviour.
- Increasing motoring costs per kilometre mitigates road traffic growth. This alone can already improve locational accessibility.
- Locational accessibility can be improved further thanks to congestion surcharges.
- Combining a congestion charge and a kilometre charge is the most effective option.
- Pricing policy can result in additional revenue that can be used to build additional infrastructure, the building of which leads to an additional mitigation of congestion growth.
- With most options, the impact of pricing policy on locational accessibility is greater than the impact of building additional infrastructure.
- Regional options are effective in mitigating local congestion growth.

The following chart shows the impacts of the various policy options developed by the platform on 'A Different way of Paying for Road Use' on lost travel time.



A Different Way of Paying for Road Use

Impact of policy options on the environment, safety and spatial planning

Ministry of Housing, Spatial Planning and the Environment
Ministry of Transport, Public Works and Water Management
25 March 2005

Management summary

The platform on 'A Different Way of Paying for Road Use' was set up late 2004 to provide an opinion on a road pricing policy that can receive broad public support. The platform is composed of a broad cross-section of societal organisations involved in transport. Various studies are being carried out for the purposes of discussions within the platform, converging in the impact study on 'A Different Way of Paying for Road Use' by the CPB (Central Planning Bureau). One of the study areas is external effects, which refers to effects on the environment, traffic safety and spatial effects.

The purpose of this report is to provide an understanding of the external effects of the policy options for road pricing as proposed by the platform on 'A Different Way of Paying for Road Use'. The impact of the different options are based on traffic calculations by the AVV (Transport Reseauch Centre), Ecorys and 4-Cast and calculations by the Environment and Nature Planning Bureau (MNP) as far as environmental effects are concerned.

Impact on the environment
The analysis of the impact on the environment focused on national emissions of CO_2 (carbon dioxide), NO_x (nitrogen oxides) and PM_{10} (particulates). The impact on noise and local air quality could not be quantified in the time available; based on earlier studies, however, it was possible to make some statements. The figure below presents the results of the analyses. The effects on CO_2, NO_x and PM_{10} emissions for passenger traffic are expressed as indices over the reference variant in 2020. The reference variant refers to the effects of expansion of the road network with the so-called *zsm – projects 1 and 2* (utilisation projects) as well as the implementation of a € 14.5 billion investment package, without an additional pricing policy or additional measures aimed at cleaner vehicles (emissions standards and incentive measures).

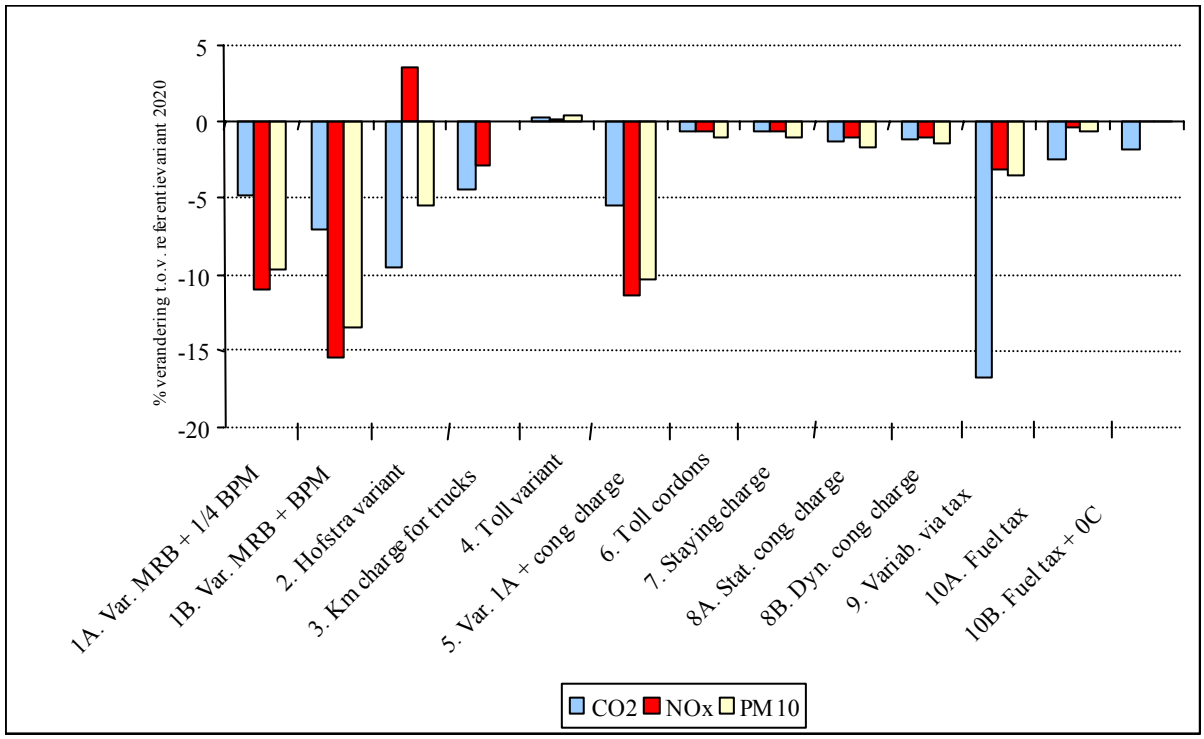


Figure 1. Impact (median estimate) of policy options for road pricing on total CO_2, NO_x and PM_{10} emissions by road traffic in 2020, in percentage changes over the reference variant in 2020. The effect of option 3 includes increased emissions in inland navigation and rail. A decrease in emissions (bar below the zero line) is an improvement. (Left column reads: % change over reference variant 2020 – for translation of policy options see above report on traffic impacts.)

The following conclusions regarding the impact on the environment can be drawn:

- Of all options studied, options with variabilisation of the fixed motor vehicle taxes (MRB en BPM[2]) result in the greatest environmental gain: variabilisation of fixed car costs results in a decrease in road traffic as well as, to a greater or lesser degree, an improvement in environmental performance per kilometre driven. Variabilisation of car costs through fuel duties results in relative terms in the strongest improvement of CO_2 emissions through fuel efficiency improvements (consumers are encouraged to buy more economical cars), while variabilisation through a kilometre charge results in the greatest reduction in NO_x (and to a lesser degree PM_{10}) emissions.
- Current car taxes have significant "greening" effects (relatively favourable effects on the environment) because of the level and basis of the purchase tax (BPM), differentiation by weight in the motor

[2] MRB: fixed motor vehicle tax / BPM: purchase tax on motor vehicles.

vehicle tax (MRB) and fuel surcharges for diesel in the MRB and BPM. Variabilisation of car costs according to the Hofstra-option results in a mitigation of road traffic but has an unfavourable effect on the environmental performance of the passenger car fleet. This is because the rate differentiation is 'flatter' than the current differentiation of the MRB and BPM. This will lead to an increase in the diesel share of the passenger car fleet, which is unfavourable for emissions of NO_x and PM_{10}.

- The policy options investigated with charges for specific locations, such as a congestion charge, toll or the entry charge, do not result in additional improvements in environmental performance per kilometre driven, so that the reductions in emissions on a national scale are in proportion to the decrease in car use.
- The introduction of a kilometre charge for heavy goods on the main road network in accordance with the German toll system will result in a decrease in national emissions by trucks of about 3% in 2020. The decrease in road transport, however, is compensated partly (NO_x and CO_2) or entirely (PM_{10}) by an increase in emissions by inland navigation and rail transport, owing to the fact that about two thirds of the tonne-kilometres eliminated from road transport will shift to inland navigation or rail transport. The environmental performance of inland navigation vessels and diesel goods trains in 2020 is worse than that of trucks because of lagging standards. In the short term (2010), the introduction of a kilometre charge for heavy goods will result in a greater reduction in emissions and can thereby improve air quality along roads. This is because the charge for heavy goods differentiates by environmental class, which can result in the short term in an accelerated shift to cleaner trucks for these are subject to a lower rate. This effect has not been included in the calculated emissions reduction.

The following comments and nuances can be added to the above conclusions:

- The analysis was especially focused on national emissions. At present, there are obstacles in road infrastructure projects because EU air quality standards have not been achieved. Variants with little effect in national terms (local charges) may have effects locally, but expectations should not be too high. Earlier research, for example, indicates that an entry charge around major cities can result in a 10%-30% decrease in homes where the NO_2 standard is exceeded. These effects may be smaller in practice, partly because it is expected that there will be more goods traffic, with relatively high emissions per kilometre, because of better flow. Further study is required for more detailed information. The Environment and Nature Planning Bureau (MNP) indicates that for effects over the short term, reducing the maximum speed on ring roads around large cities will be more effective, as this can improve the environmental performance per kilometre of passenger cars as well as trucks by 25%-30%.
- There is an important relationship between the rate structure and the composition of the fleet. If the rate structure contains no incentives promoting fuels and vehicles that are relatively environmentally

friendly, there will be more diesel vehicles and heavier vehicles. In that case, the basic condition imposed on the Platform in terms of the environment – at least the same effects as in the situation without a price policy – will not be achieved.
- Environmental effects may improve through further optimisation of the rates in environmental aspects. Differentiation by polluting emissions (Euro class or model year) for passenger cars as well as trucks may result in an incentive to accelerate the renewal of the fleet, with favourable effects for NO_x and particulates. Differentiation by location, such as higher rates in areas with a large amount of air pollution and/or noise pollution, can increase the impact on the environment.

Traffic safety

The following conclusions can be drawn in terms of safety:
- Policy options involving a kilometre charge for at least all passenger vehicles have the most favourable effect: the reduction in vehicle kilometres means that safety clearly improves. The impact is smaller if the number of participating vehicles is smaller, e.g. in case of a kilometre charge for heavy goods, or if there is a congestion charge.
- When the policy options are developed further, special attention will have to be paid from a safety perspective to the impact on the secondary road network, because the secondary road network is less safe than the main road network. It may be necessary to price the secondary road network and/or take additional measures to make diversions via the secondary road network unappealing (traffic reduction measures). The rate system will also require additional attention to prevent unwanted side effects such as driving fast to leave the charge area before the charge period or waiting on the shoulder until the charge period is over.

The following table provides a rough estimate of the improvement in safety for each policy option. Note that this is not a calculation but an estimate based on earlier research and the latest calculated traffic impacts. Given the limited time available, the safety effects could not be calculated using the recent traffic data.

Summary: traffic safety estimates

	Policy options of the Platform	**Estimate based on previous research**	**Estimate of options of Mobility Policy Document**	Vehicle kilometres **Recent run of National Model System (decrease/increase, %)**			**Estimated safety improvement (%)**
				Main	**Secondary**	**TOT**	
	Build & use (reference)	0	0	0	0	0	0
1	Kilomtre charge MRB + ¼ BPM	++	++	-8	-9	-8	8
	MRB + BPM			-11	-12	-11	11
2	'Hofstra' charge	++	++	-11	-12	-11	11
3	Kilometre charge– heavy goods	0	n/a	-	-	-	+/-/?
4	Group of 6 toll cases	0	n/a	0	1	0	+/-/?
5	Kilometre charge and congestion charge	+++	++	-10	-9	-9	9
6	Entry charge in four major cities	+	0/+	-2	-1	-1	1
7	Area -wide charge in four major cities	0	0/+	0	-1	0	+/-/?
8	Charge on congested corridors fixed rate	+	0/+	-4	0	-3	3
	Dynamic rates			-3	-1	-2	2
9	Charge through tax	++	n/a	-4	-5	-4	4
10	Tax increase to finance ambitions of *Mobility Policy Document*	+	n/a	1	-1	0	+/-/?

A study is currently in progress on the relationship between vehicle characteristics and traffic safety, so that there will be more insights in the near future into the relationship between the type of car and safety. If this results in good possibilities for operationalisation, it will be recommended that this be incorporated in the rates for a pricing system. Current insights indicate that behaviour (with alcohol, seatbelts and speed as characteristics) accounts for more than 50% of accidents. It is also a fact that cars with a greater mass cause more injuries in the event of a collision than lighter cars, making this the most objective and measurable criterion for determining the external danger of a vehicle. A rate that depends on mass is therefore defensible for traffic safety reasons.

Spatial effects
A unequivocal picture of the impact of price measures on spatial development cannot be provided. This is partly because of the lack of experiential data and partly because of the fact that impacts are expected to counteract each other. All types of kilometre charges, congestion charges and tolls may change motorists' behaviour, resulting in a reduction in the number of car journeys and with it, more efficient use of the road network and possibly better accessibility of centres and economic areas. This can support spatial policy. The kilometre charge differentiated by time and location in particular provides the possibility of directing spatial developments, but also the area-wide and entry charges may support and guide spatial developments.

IT IS POSSIBLE!

A Different Way of Paying for Road Use: technology, organisation, enforcement and costs

29 March 2005

Management summary

The platform on 'A Different Way of Paying for Road Use' has been asked to issue an opinion to the Dutch Minister of Transport, Public Works and Water Management and the Dutch Minister of Finance on a form of road pricing that improves locational accessibility and can rely on broad support. Various road pricing systems are used elsewhere in Europe, with different purposes, technologies, basic conditions and costs. This leads to the conclusion that there are many options in technical and organisational terms.

The platform has asked to study the effects and costs of 10 policy options for a different way of paying for road use. This report addresses the issue whether the proposed options can be realised (in terms of technology, organisation and enforcement), what time of implementation is required and the approximate costs of each option. This report does not address the two tax options, as it is already clear that the costs are virtually zero and the introduction time is very limited, compared to the other options.

The report is intended for a comparison of very different options, with different goals, preferences and characteristics. Assumptions have been made for the study, such as the area of application (all of the Netherlands or regionally; main road network only or including secondary road network) and estimates of the number of road users. When the goal and the preferences and requirements (including political ones) of a different system of paying for road use will be clear, more precise specifications and cost estimates can be made in a subsequent phase.

Summary of policy options with most important characteristics.
Amounts in millions of euro

Policy Options	INVESTMENT	DEPRECIATION Annually	OPERATION Annually	INTRODUCTION
1 & 2 kilometre charge	2100 – 3800	400 - 700	400 - 1100	2011 - 2016
3 Kilometre charge, heavy goods, GPS	180 – 365	35 – 70	35 – 90	2009 - 2012
3 Kilometre charge, heavy goods, gateways	300 – 360	45 – 60	60 – 160	2009 - 2012
4 Various toll projects	100 – 130	25 – 35	60 – 190	2009 - 2012
5 Kilometre charge + congestion surcharge	2200 – 4100	400 – 800	500 – 1100	2011 - 2016
6 Entry charge in the four major cities	115 – 150	15 – 25	25 – 45	2009 - 2011
7 Area-wide charge in the four major cities	200 – 300	65 – 105	265 – 420	2009 - 2011
8 Charge on congested corridors	85 – 95	10 – 15	20 – 35	2009 - 2011

All policy options can be implemented
All policy options assume free flow systems (no barriers): road users can pay without stopping. In principle, each option is possible in practice. In all cases, basic conditions such as privacy, European regulations and requirements regarding reliability and enforceability can be met. The implementation and with it, the consequences and risks, however, do differ.

Many policy options have already proved themselves abroad or are now being tested in practice. Only the options involving a kilometre charge for all road users on all roads are new in terms of the scope of the number of road users and the area of application. Even though technology, organisation and enforcement are scaleable in principle, there are still risks. The risks involved with this innovation result in higher costs and longer introduction periods.

Major differences between policy options
The implementation of the policy options differs to a large extent. This applies in the first place to the required provisions in the vehicle of the users: no On-Board Unit (manual declaration system), a simple On-Board Unit (DSRC technology) or a more complex On-Board Unit (GPS technology). The consequences for roadside infrastructure are also different: DSRC technology requires more gantries than manual declaration systems and satellite-based systems, but the latter two require more roadside investment for enforcement equipment and other enforcement strategies and tactics. No technology is quickest to implement and cheapest in all aspects. Nor does each technology suit each goal equally: satellite-based (GPS) systems are more suitable for a large area with many users. Radio communication technologies (DSRC) are better for variants with many users (who also return regularly) in a restricted area or on a limited number of routes. Manual declaration (with plate recording as the enforcement system) is especially suitable for a limited number of users in a restricted area.

Public or private implementation
A different way of paying for road use always requires a foundation in public law. Implementing parts of a road pricing option can be done by both public and private parties. This will be specified further before tendering. Current analysis, however, already indicates that for certain functions, such as halting and issuing sanctions (e.g., collecting fines), implementation by public organisations is preferable for reasons of safety as well as cost, without ruling out private implementation. Once a policy option has been selected and the goals, requirements and preferences are clarified, the legal framework can be developed further, including options for public-private structures and corresponding cost allocations.

Introduction periods
Introduction is particularly determined by the time needed for legislation and the size of the number of road users and the area of application. Regional applications can be introduced more quickly than national applications. For a national kilometre charge, for example, there are approximately 8,000,000 road users who will all need to be equipped with an On-Board Unit (which also largely accounts for the high cost of these national variants). This requires a considerable length of time in terms of production and installation. In all cases, the length of time for legislation is at least 1.5 years, but in the event of a small delay in the legislation process, decision-making will be around the time of elections in the Lower Chamber and the subsequent formation of a new government. This means legislation for each option may be delayed by one year. European tendering rules ensure that this phase has a minimum as well, which is one year. Gains may be made by running phases in parallel (such as the legislation and tendering phases), but this implies cost risks.

Future developments and growth options
A pricing system initially introduced may be expanded, adapted or replaced over time. Migrations are generally difficult to plan as a result of the political context, so that investments made do not appear optimal in retrospect. Building in flexibility for applications makes sense to a certain point. Keeping every conceivable growth or migration trajectory open in technical terms is not possible and is not recommended in an economic sense. If a predicted migration takes a long time, there is also a good chance that developments in technology or European harmonisation will have superseded the 'old' concept. This is especially true for systems with on-board measuring and registration of usage (systems generally based on satellite technology), for which standardisation is still in development. In the latter case, it may be more attractive to invest now in technology that is already widely applied (DSRC technologies) and actively follow other developments in Europe and in the industry, regarding On-Board Units with various applications based on satellite technology.

Ultimately, the question is whether there are significant investments to be depreciated at an accelerated rate because of migration. It is also important for citizens not to lose track where different systems co-exist.