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MITIGATING THE IMPACT OF THE ROAD SYSTEM ON CLIMATE CHANGE

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1. INTRODUCTION

This report begins with an outline of the targets set by the Norwegian government for emissions reductions in the transport sector. It goes on to discuss the emission reduction potential of some specific measures to lower emissions in the transport sector. Finally, it assesses policy instruments that might be used to implement some of the measures.

This report draws on a study done by the cross-departmental working group Klimakur 2020 or Climate Cure 2020. In 2008 the Norwegian Ministry of the Environment gave the Climate and Pollution agency the task of leading Climate Cure 2020 in analysing measures and policy instruments for reaching the targets of reduced CO2e emissions of 15-17 million tonnes. Their findings will form the basis of the Government's evaluation of the environmental policy which will be presented to the Storting in 2011.

The section of the Climate Cure report dealing with the transport sector was performed by the Norwegian government transport agencies and Avinor (the Norwegian civil aviation authority), and has drawn on reports by external consultants and estimates from different subject areas. The reports are available on the website of Climate Cure 2020: www.klimakur.no.

2. TARGETS

The Climate cure analysis is based on the goal of national emission reductions agreed upon with a majority in the Norwegian Storting in 2008. It was then stated the emissions of CO2es should be reduced by levels exceeding the levels Norway has committed to through the Kyoto Protocol with 10 percent. In total, Norwegian emissions are to be cut with 15 – 17 million tonnes of CO2 equivalents by 2020, so that domestic emissions do not exceed 45-47 million tonnes CO2 equivalents in 2020. Emissions from the transport sector are to be reduced with 2.5-4 million tonnes. The mandate of the Climate Cure work group was to determine and analyse the different alternatives to reach the goal, without making recommendations.

Of the sectors analysed, the transport sector is responsible for the highest levels of CO2e emissions, and has the highest potential for emissions reductions. Demand for transport services increases with economic and population growth. Without new or stronger instruments, baseline scenario projections show that greenhouse gas emissions in the Norwegian transport sector can be expected to increase from the present 17 million tonnes of CO_2 equivalent to about 19 million tonnes in 2020 and 21 million tonnes in 2030. This scenario incorporates several measures already introduced to curb greenhouse gas emissions, including a CO_2 tax on fuel. Assumptions regarding technological improvements are also incorporated in the baseline scenario.

The purpose of the Climate cure transport analysis was to show how emissions from the transport sector can be reduced by at least 2.5-4 million tonnes of CO_2 equivalent relative to the baseline scenario for 2020, and preferably exceed this goal.

The Climate Cure transport analysis demonstrates that it may be possible to achieve emission reductions of the order of 3-4.5 million tonnes of CO_2 equivalent in 2020, using strong instruments, large investments and transfers. Implementing the measures will require a strong political will.

According to the analysis, the largest emission reductions can be achieved through measures associated with biofuels and vehicle technology, estimated to be of the order of 1.8-1.9 million and 0.8 million tonnes respectively, or a total of 2.6-2.7 million tonnes. By developing the public transport sector and increasing car and/or air transport a potential emission reduction of a further 1.2-1.4 million tonnes was found. Other measures are estimated to have a potential of about 0.8 million tonne per year.

The estimated costs of the measures considered are mainly less than NOK 1 500/tonne, but some are substantially higher. A number of measures prove to be socioeconomically profitable.

The effects of a number of measures and instruments by 2030 have also been evaluated. It is assumed that the potential of technical measures for vehicles will be substantially larger in 2030 than in 2020 because it takes time to introduce new technology. In total, it is estimated that the measures analysed may result in total emission reductions of up to 8-12 million tonnes by 2030. The estimate is not complete.

To bring about the measures, in both 2020 and 2030, it is necessary to use taxes, invest in infrastructure, provide information about and introduce incentives to promote technical solutions and environmentally friendly transport. There appears to be considerable potential for the introduction of new vehicle technology such as electricity and possibly also hydrogen, and a higher share of renewable biofuels. However, it takes a long time to develop new technology and to replace the Norwegian vehicle fleet, so technology based on petrol and diesel will continue to account for the bulk of the vehicle fleet in 2020. There is a considerable potential for replacing the vehicle fleet and for zero-emission and low-emissions vehicles by 2030 and 2050.

3. MEASURES

In the transport sector, measures were analysed in the road, vehicle technology, rail, shipping and aviation, in addition to overall measures. The measures with the highest potential for CO_2e emission reductions will be discussed in this report. For further information the Climate Cure report can be consulted (Klima- og Forurensningsdirektoratet et. al., 2010).

Figure 1 and 2 show the potential for emission reductions estimated for groups of measures in 2020 and 2030 respectively. The figures show that the potential is greatest and the costs lowest for energy efficiency measures and measures that reduce emissions from the individual means of transport through the use of biofuel and electrification. There is also considerable potential associated with a change in the distribution of means of transport (development of public transport supplemented by taxes on car traffic and development of goods transport by rail), but the costs are quite high. Note that by 2030 the potential for energy saving has largely been exhausted, so that in some respects these measures have become more expensive than biofuel and electrification. There is assumed to be a very high potential for biofuel in 2030. This presupposes a sufficient supply of and development of second generation fuel. The calculations have been carried out by different methods, and the costs are not directly comparable.

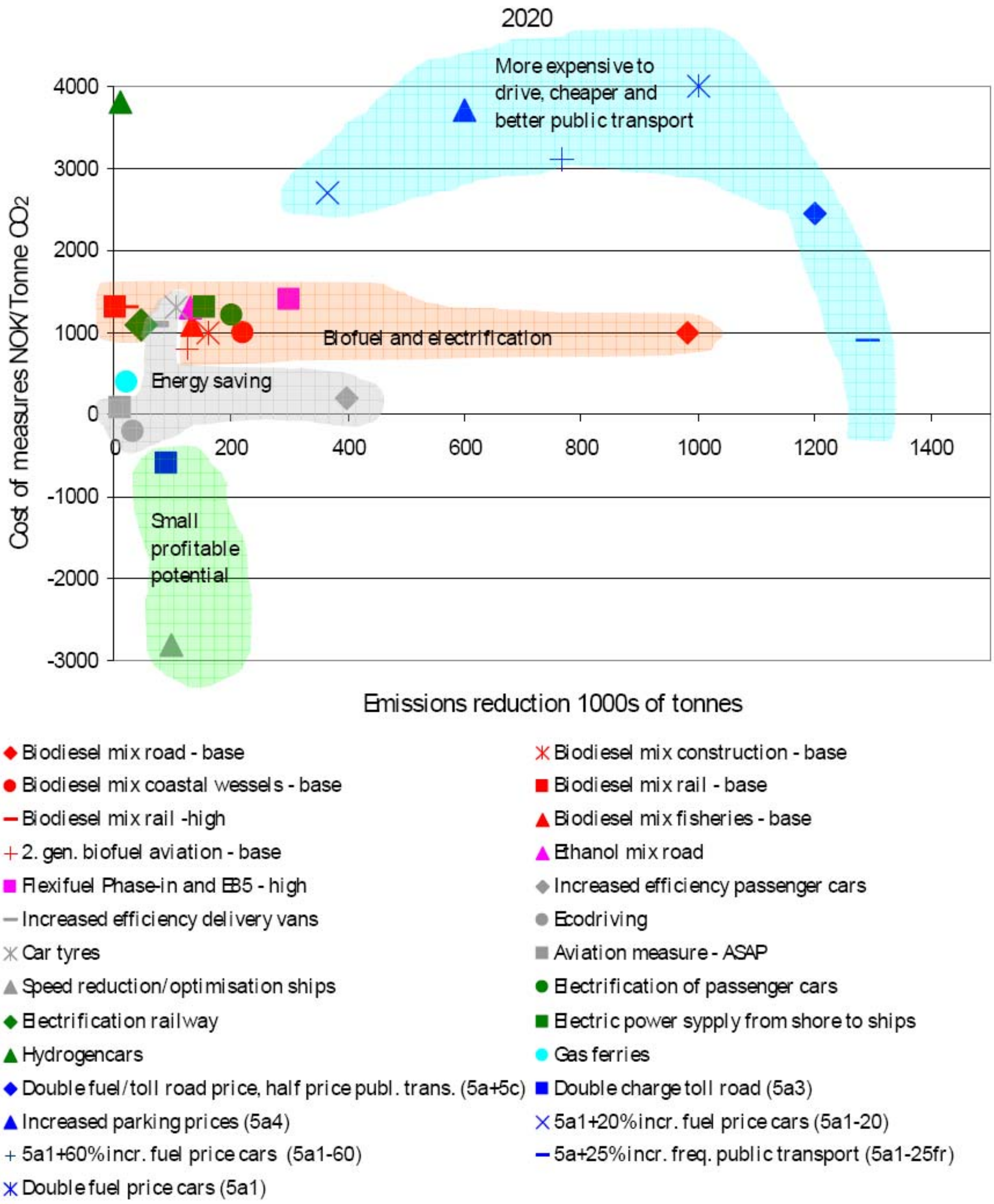

Figure 1 – Potential emissions reductions by 2020

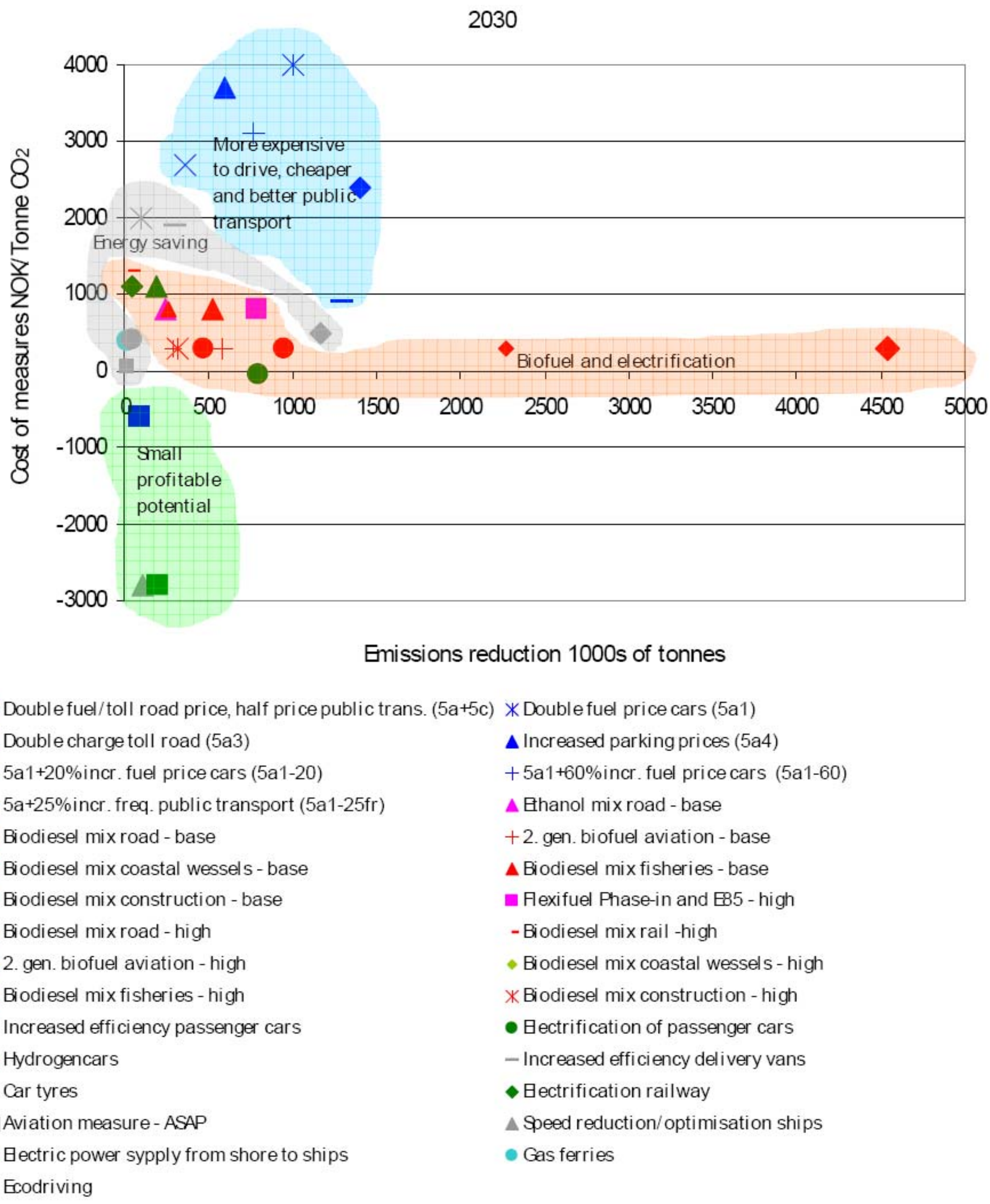

Figure 2 – Potential emissions reductions by 2030

3.1 Biofuels

It is estimated that phasing in biofuels would potentially result in reductions of 1.7-1.9 million tonnes in 2020 and 3.8-7.7 million tonnes in 2030. The lower estimate assumes a 10 per cent biofuel mix for all types of transport in 2020 and 20 per cent in 2030. In the high estimate, the mix is assumed to have increased to 40 per cent in 2030.

The costs vary from NOK 800-1400/tonne in 2020 and from NOK 300-1300/tonne in 2030. It is important to note that in these estimates of CO_2 gains, it is assumed that 100 per cent of the biofuel is imported. CO_2 emissions associated with the production of raw materials and biofuel will then take place in the country of origin. This manner of calculation is consistent with that in the method report of Climate Cure 2020, and means that the measures will result in a 100 per cent CO_2 gain for Norway. Assumed emissions in other countries are described in the measures forms. If these were to be taken into account, the effect of mixing in second generation biofuel would be reduced by some 10 per cent, while the effect of mixing in first generation biofuel would be reduced by about 30-50 per cent, depending on which raw material was used. It is assumed that only certified biofuel is used in the future. This means that sustainability and climate potential requirements would be made of the fuel. These requirements, which are being formulated by the EU, are intended to ensure that the conflict between food production and threatened species of animals and high-nature-value areas are kept to a minimum.

The high mix scenario in 2030 is assumed to bring about an overall reduction in greenhouse gas emissions of 7.7 million tonnes in 2030, of which almost 7 million tonnes stems from the use of second generation biodiesel. Second generation biofuel is in an early phase of technological development. It is very uncertain whether it will be possible to industrialise this fuel to any particular extent before close to 2030.

The potential depends on a substantial share of biofuels in the vehicle fleet. These calculations are limited to domestic emissions. Account has therefore not been taken of any changes in emissions abroad as a result of increased use of biofuels, and it is assumed that there is a sufficient quantity of biofuels available on the market.

3.2 Doubling the share of bicycles

The measure involves building an interconnected main network for bicycle traffic in towns and built-up areas with more than 5 000 inhabitants, improved operation and maintenance, and information and campaigns. The transfer potential from car to bicycle is estimated to be 1.1 billion person-kilometres per year. An assessment of the size of an interconnected main network for cycle traffic in towns and built-up areas has been made on the basis of plans for such a network in the southern counties. The emission reduction potential is estimated at 143 000 tonnes of CO2, and the estimated socioeconomic gain at between NOK 3 000 and 12 600/tonne, i.e. a socioeconomically profitable measure. The time costs have been very roughly estimated on the basis of an average transferred trip. This estimate has a major bearing on the results. The gain largely takes the form of a health benefit.

3.3 Increasing the efficiency of passenger cars

The potential emission reduction is estimated to be 397 000 tonnes CO_2 over and above the increase in efficiency already incorporated in the baseline scenario. The estimated cost is NOK 185/tonne. The greater increase in energy efficiency is made possible by the EU law on CO_2 emissions from passenger cars, whereby emissions must be reduced from about 160 g/km in 2008 to 130 g/km from 2012-2015 (phase-in), and further to 95 g/km in 2020. It is assumed that a certain percentage of electric vehicles, plug-in hybrid vehicles and possibly hydrogen vehicles will have to be sold in 2020 to bring the average emissions from passenger cars in Europe down to 95 g/km. The average emissions from new passenger cars with combustion engines are accordingly assumed to come down to about 106 g/km in 2020 in Europe, and it is assumed that this will also be the average in Norway. However, this presupposes continued active differentiation of the purchase tax according to CO_2 emissions. Some of the reduction that this implies is already incorporated in the baseline scenario. A possible increase in energy efficiency of about 1.0 per cent per year is estimated between 2020 and 2030. In addition the measure contains small technical requirements with respect to increasing the energy efficiency of various car components that will be implemented through a number of EU directives and laws. In 2030, the average car with a combustion engine will emit about 90 g/km, which is the same as the 2010 model of the Toyota Prius. This is a level that the International Energy Agency, among others, considers could be realised by 2030.

3.4 Car tyres

The measure entails car tyres with lower rolling resistance than is required by general car safety regulations. The potential emission reduction in 2020 is estimated at 106 000 tonnes of CO_2. The costs are estimated at NOK 1 280/tonne. A somewhat lower potential and higher costs are expected towards 2030 because cars will become more efficient, which reduces the value of the smoothly rolling tyres. An increase in the energy efficiency of passenger cars is expected to take place first. The measures will affect the whole vehicle fleet, both existing and new. As a result of the use of winter tyres, the reduction is expected to be somewhat less in Norway than in the EU.

3.5 Electrification of the vehicle fleet

The measure involves introducing an increasing number of electric cars and plug-in hybrid cars into the vehicle fleet. It is based on the two technologies being developed and commercialised by several large car manufacturers and will be manufactured in large quantities with falling costs, with launching in 2011-2012. Assuming that the increase in efficiency and car tyre measure take place first, the potential emission reduction is estimated at 203 000 tonnes CO_2. Estimated costs are NOK 1 180/tonne in 2020, and a higher potential and rapidly falling costs are expected towards 2030. Short-range electric cars will have the greatest need for a public recharging infrastructure. For the plug-in hybrids, better access to a public recharging structure will increase the proportion of electrical operations. A scenario has been developed for the introduction of a recharging infrastructure which assumes that there are public recharging stations for 15 per cent of the plug-in cars that are sold up to 2020 and 2030 and a limited high-speed recharging network.

Costs are very sensitive to the assumptions that have been made, and there is therefore a substantial uncertainty interval surrounding the estimated cost effectiveness.

3.6 Hydrogen in the passenger car fleet

Assuming that the increase in vehicle efficiency and the car tyre measure take place first, the potential emission reduction is estimated at 11 000 tonnes CO_2, and the estimated cost is NOK 3 810/tonne in 2020. A substantially greater potential is expected and a falling cost towards 2030. A slow market introduction is assumed from 2016. This corresponds to the car manufacturers' launch strategies. A number of car manufacturers announced in September 2009 that they will start launching cars in 2015 and that during the first few years a few hundred thousand will be produced globally. This means that that the volume that can be expected in Norway up to 2020 is very limited. After 2020, growth is expected to remain slow until costs reach an acceptable level and growth is assumed to pick up. The measure is based on the assumption of a breakthrough on the last remaining problems for hydrogen cars, i.e. that the life of the fuel cells will increase to the life of the car while costs will fall to the level outlined in this measure. The greatest challenge to the hydrogen measure lies in the fact that costs in the 2015-2030 perspective will be substantially higher than the costs of electrification, given the assumptions made here. However, the biggest advantage hydrogen has over electricity is the rapid filling speed coupled with range, which makes hydrogen an option in all passenger cars.

There is great uncertainty associated with technological development in the future, and which of the alternatives will win in the end is by no means given.

3.7 Increased efficiency in delivery vans and heavy vehicles

The EU regulation on emissions from delivery vans means that there will be an increased number of delivery vans with low emissions available. New instruments may be necessary for this to bring about a similar reduction in the Norwegian delivery van fleet. The potential emission reduction is estimated at 65 000 tonnes CO_2, and the estimated costs at NOK 1 000 – 2 600 /tonne in 2020. A greater potential is expected towards 2030, but higher costs. The increased efficiency for heavy vehicles projected in the baseline scenario is so ambitious that there does not seem to be scope for further technological improvements in new vehicles. In the perspective report it is assumed that fuel consumption, and hence CO_2 emissions, will be reduced by 1 per cent per year.

CO_2 emissions are measured as a standard test for type approval of light vehicles, passenger cars and delivery vans, and it is a requirement that the CO_2 emissions be quoted to car buyers and in advertisements. This means that the CO2 emissions can be used for calculating taxes. There is no requirement that the CO_2 emissions of heavy vehicles be measured or stated. The great diversity of heavy vehicles, with small production volumes for each variety and high costs for testing complete vehicles makes it difficult to introduce a requirement that measurements be taken. If specific instruments are to be established to boost the sale of heavy vehicles with low emissions, the emissions from each vehicle will have to be known.

The EU is developing a system for labelling the CO_2 emissions of heavy vehicles that entails a mixture of measurement and calculations. Labelling the vehicles' emissions will make it possible to use incentives to increase sales of vehicles with low emissions and make vehicles with high emissions less attractive. If such a labelling scheme is used, it will be possible to introduce instruments to reduce the emissions from heavy vehicles. Until then, taxes on diesel will be the principle means of influencing vehicle buyers.

3.8 Improved public transport in the six largest cities

The measure involves increased frequency, lower fares and a change in carriage size. Investment in infrastructure is not included. The effects are simulated with different economic parameters, where fare level /government subsidy vary. The estimated emission reduction without an upper limit to government subsidies for this option is 65 000 tonnes. A socioeconomic gain of NOK 25 000 /tonne is estimated, which is largely due to the benefit of a better offer for existing users of public transport. The increase in government subsidy is estimated here at about NOK 3 billion/year. With an upper limit of 10 per cent to the increase in subsidy, the effect of the emissions is reduced, but the benefit increases. With restrictions on car traffic (lower parking coverage and higher vehicle-related costs, options 3 and 4), emission reductions increase somewhat, while the benefit is estimated at NOK 38 000/tonne. The cost per tonne is higher in the packages of measures and instruments that are simulated using transport models, partly because these cover public transport throughout Norway, including major investments.

3.9 Ecological Driving

Ecological driving is a style of driving that can reduce fuel consumption through simple adaptation to the characteristics of the combustion engine with respect to efficiency under different operating conditions. It is assumed that taking an ecological driving course is voluntary. It is assumed that annual public campaigns will each year prompt 1.5 per cent of driving licence holders (3 million in all) to take an ecological driving course. 35 per cent of them are assumed to actually use ecological driving in practice, with 90 per cent of the theoretical effect, which is assumed to be a 10 per cent reduction. In other words, a reduction of about 3 per cent is assumed for the average motorist who completes an ecological driving course. In 2020, 450 000 motorists will have completed the course, and if it is assumed that each of them has a car that has a somewhat higher annual mileage than the average car in the vehicle fleet, emissions in 2020 will be reduced by about 32 400 tonnes with a socioeconomic gain of about NOK 200/tonnes CO2. There is also potential for ecological driving of heavy vehicles, but this has not been estimated.

4. ASSESSMENT OF POLICY INSTRUMENTS

The following chapter discusses some of the policy instruments that may be used to implement the measures discussed in the previous section.

A large number of policy instruments that affect emissions of CO_2 in the transport sector are already in use in Norway, including a CO_2 tax on fuel, a government order to market biofuel, vehicle taxes, emission control requirements from the EU, the Norwegian Planning and Building Act, the reward scheme, Transnova and the NO_x fund. In order to reduce emissions, today's use of instruments must be stepped up, and/or new instruments employed. The use of instruments shall contribute to a change to lower emission intensity in the transport sector. Emissions of greenhouse gases in the transport sector take place as a result of the choices of a very large number of individuals in connection with the amount and means of transport available. It is difficult to change the habits of users. For them to be persuaded to undertake long-term investment to reduce emissions, they must be confident that the policy is stable, also in the long term.

The instruments are divided into three main groups:

- economic instruments
- regulatory instruments
- information, expertise and R&D (research and development)

Some of the measures can be activated through individual instruments and in some cases only through a combination of instruments. For example, use of biofuel can be brought about by an order to market the fuel (regulatory instrument) or by taxes (economic instrument). Moreover, some of the measures studied will affect one another: for example, a large proportion of low/zero emission vehicles will lead to various measures to reduce passenger car traffic having less effect on emissions. The effects of the instruments will vary through the introduction phases of the measure and on into an operations phase, and will be influenced by market and technological developments, so that there may be a need to adjust the use of instruments along the way.

4.1 Economic instruments

4.1.1 Fuel prices (fuel and CO_2 taxes)

The price of fuel influences the users' choice of type of transport, the amount of transport and the composition of the vehicle fleet. The price of fuel depends on the level of taxes on petrol and diesel and on international oil prices. The CO_2 tax accounts for only a part of the price of fuel, and therefore has to be substantially changed to give it enough effect on price to influence behaviour. Depending on their size, taxes may contribute to reduced transport activity, a switch to other forms of transport, and may influence the composition of the vehicle fleet.

Calculations show that increasing the price of fuel for cars and possibly aircraft has a positive effect on emissions, but also high costs. The social consequences of very high price rises have not been considered. The rise in price may for example be achieved by sharply increasing the current CO_2 tax. The CO_2 tax is a cost-effective instrument, since it gives all sources the same incentive to reduce emissions. The administrative costs are low because the collection system already exists. However, even with a far higher CO_2 tax than the current level, calculations show that the CO_2 tax will constitute a small share of overall user costs. Because of popular resistance, it may be difficult to substantially increase the fuel price. Other tax systems could also be introduced, such as kilometre-based tax (“road tax”) for heavy vehicles, but this would be more costly (Vista analysis AS 2008). To reduce air traffic or transfer it to less emission-intensive forms of transport, airfares can be increased by raising fuel or landing taxes to reduce the incentive to fly.

The level of CO_2 tax needed to achieve the national emission target varies from NOK 1 200 to over NOK 3 000/tonne of $CO_{2,}$ depending on the sectors to which the tax is applied.

Transport model simulations were used to model increases in fuel prices (20, 60, 100 and 200 per cent) which will substantially increase the costs of driving. Higher fuel taxes represent a large potential, but give rapidly increasing costs per tonne, estimated at between NOK 2 500 and NOK 5 200/tonne, which is relatively high compared with other measures in the sector. A doubling of the fuel price by means of the CO_2 tax is equivalent to a tax some 20 times as high as today (or a crude oil price of over USD 300/barrel at the current tax level). Clear signals should be given before initiating tax increases, so that those affected have time to adapt to a new tax level.

The effects of increasing the fuel tax on the composition of the vehicle fleet and emissions from each vehicle have also been calculated. A higher fuel tax or CO_2 tax will make it profitable to invest in petrol and diesel vehicles with lower specific emissions and possibly also to speed up the replacement of older vehicles. The results show a significant effect for a 60 per cent rise in fuel prices.

4.1.2 Purchase tax

A stronger shift towards purchase of petrol and diesel vehicles with lower emissions could be achieved through further differentiation of the purchase tax. So far experience of this differentiation has been good, and simulations show that further differentiation, coupled with high fuel taxes, will contribute to more rapid introduction of more efficient vehicles into the Norwegian market. As a result of the EU’s new requirements regarding emissions from new passenger cars, however, the effects of further differentiation of the purchase tax will wane in the years ahead, because when the average emission is reduced there will be less difference between cars’ emissions.

An expected increase in the efficiency of the vehicle fleet is forecast to contribute to an emission reduction of about 400 000 tonnes of CO_2 at a cost of less than NOK 200/tonne. This is very cost-effective compared with other measures in the sector. In addition, the introduction of better car tyres, which is also a move to increase efficiency, will lead to further reduction, to slightly over 100 000 tonnes.

In isolation, lower purchase prices for petrol and diesel cars will make it relatively less profitable to introduce vehicles based on alternative fuels. Further reductions in purchase taxes could be given to plug-in hybrid vehicles and vehicles based on biofuels in order to maintain the competition between petrol and diesel vehicles. This may be necessary to ensure rapid introduction of these vehicles into the market.

4.1.3 Kilometre/road tax

A type of kilometre/road tax is one possible alternative to a fuel tax if the aim is to limit general use of cars. This instrument could be introduced by Norway independently of other countries. The Ministry of Finance is considering a road tax for heavy vehicles, where the burdens the vehicles impose on the environment in the form of noise, air pollution and accidents are weighted differently depending on whether they happen inside or outside of towns.

4.1.4 Road use/congestion charging

The term "congestion charging" is used for a tax system designed to regulate rush-hour traffic and hence reduce congestion problems, improve the traffic flow and create a more agreeable urban environment. Congestion charging is most relevant in cities with a lot of traffic and congestion problems and is a variant of road-use charging. Congestion charging has not been introduced into Norway as yet, but is being considered in several cities. Toll fees are being collected at a number of places in Norway to finance transport projects.

Local use of a rush hour tax to reduce the queues in the bigger cities may be an effective means of reducing traffic queues and the associated disadvantages (cf. experience with road use charging in Stockholm). Such a tax may also contribute to reducing CO_2 emissions, since it reduces traffic and does not merely shift the traffic towards times of the day with smaller queues. If a high CO_2 tax on fuel is considered to have unacceptable negative effects in rural areas, an alternative solution may be a system with a lower fuel tax combined with road use charging in central areas where there are alternatives in the form of public transport.

In this analysis, the effect of doubling fees in the toll rings combined with inter-city trains and long-distance buses is simulated (cf. discussion of transport model simulations). The potential for emission reduction is estimated at 90 000 tonnes of CO_2 equivalent. However, this probably does not represent the full potential of the measure.

4.1.5 Investments and subsidies, including subsidies for more environmentally friendly transport options

Subsidies and government investment can make environmentally friendly transport options more easily available and cheaper. As subsidies help to lower transport prices, this may lead to more travel, which in isolation may contribute to higher emissions.

4.1.5.1 Cyclists and pedestrians

In isolation, an increased CO_2 tax will make it more profitable to walk and cycle, while building pedestrian and cycle paths will make it more attractive. Simulations show that the share of cycling can be doubled by building an interconnecting main network for cycles in towns and built-up areas with more than 5 000 inhabitants, improved operations and maintenance and information and campaigns. This could yield an emission reduction of the order of 145 000 tonnes CO_2 in 2020, and is estimated to be socioeconomically profitable.

4.1.5.2 Vehicles

Subsidies or tax relief are potential means of promoting the introduction of vehicles with lower emissions.

4.1.5.3 Public transport

Subsidies for public transport make this option cheaper so that more passengers may elect to switch to public transport instead of driving private cars. The reward scheme has become an important incentive for municipalities to develop public transport and cycle paths, where there is a simultaneous requirement that car traffic be reduced in order for resources to be granted. The scheme can be expanded. Investment in public transport lanes, transport interchanges; bus stops etc. can be increased.

4.1.5.4 Railway

Rail is the most energy-effective means of transport, and a transition from other means of transport to rail has a positive effect on greenhouse gas emissions. Extensive development of the railways is assumed in the transport model simulations. It requires substantial investment, far beyond the limits in NTP 2010-2019. However, the simulations show that developing options only results in minimal reductions in CO_2 emissions in isolation, unless it is combined with restrictions on motor vehicles/aircraft. A transition to biofuels or electrification of stretches that at present are run using diesel are possible measures for reducing today’s emissions from the railways. Electrification is dependent on government allocations for realisation.

4.1.5.5 Goods transport

Higher road transport costs as a result of an increased CO_2 tax will make it more profitable to transfer goods traffic from the road to the sea or railway, but various obstacles in the form of terminal capacity and track capacity mean that this potential cannot be realised without extensive investment. Developing the railway network can increase the capacity of the track and make it easier to transfer goods transport from road to rail. NTP 2010-2019 contains a doubling of the capacity of goods transport by rail. The present analysis includes a tripling of capacity by 2030. The development of terminals etc. for transferring goods from road to rail/sea and managing land use will also be important in the longer term for getting more goods over to rail and sea.

Better coordination of goods transport could reduce overall transport requirements. Relevant instruments for preparing the ground for this are:

- subsidies to projects for developing cooperative solutions
- R&D funding for standardisation of transport documents and the flow of information between operators in the transport business
- aid for introducing new technology for measuring and reporting of vehicle-kilometres and load utilisation
- strong county or central government management of land use in the municipalities

4.1.6 Economic instruments to stimulate technological development and implementation

4.1.6.1 Vehicles

A higher CO_2 tax will make it more profitable for operators in the industry to introduce vehicles based on electricity, biofuels or hydrogen and to build up supply systems for them. If the costs of introducing the alternative fuels are higher than the CO_2 tax, the measure will not be implemented in most cases, because it will not be competitive. There may therefore be an initial need for economic support to build up the distribution of new fuels and to reduce the extra costs to vehicles. Introduction can be speeded up by subsidising the building of recharging stations, and possibly reinforcing the power grid if or when high-speed recharging is available. Similarly, supply chains for pure biofuel and hydrogen can be built up more rapidly if the government provides economic support. Hydrogen may be difficult to introduce without government support for developing infrastructure.

4.1.6.2 Air travel

The implementation of technical measures in this sector is largely dependent on technological development internationally. The development of more energy-effective aircraft and the possibility of mixing in biofuel are important examples of this. New technology will mainly be developed independently of the use of instruments in Norway, and when companies buy new aircraft, they will choose the most recent technology available, irrespective.

4.1.6.3 Shipping

Various energy-saving measures such as speed reduction, cleaning of hulls and propellers, and the use of shore power in harbours are relevant for shipping. Collectively these measures are estimated to offer potential emission reductions of some 400 000 tonnes of CO_2 equivalent or more. Some of the measures are profitable given the assumptions made here, and targeted information or other instruments should therefore elicit them.

Investment will be required to supply shore power. There will also be costs associated with equipping ships and harbours for the use and delivery of shore power. Most small vessels can already receive low voltage shore power, and no major investments are required to enable these ships to receive shore power. However, one complicating factor is that no standards have been developed for shore power and connecting up to shore, so that choosing standards and adjusting existing equipment may require further investment. A requirement that shore power be used may be introduced, but should wait until there is agreement on international standards for shore power connections.

An order for energy efficiency measures and cleaning will be too difficult to enforce. However, a requirement for SEEMP (Ship Energy Management Plans) is possible, but making special requirements of Norwegian ships is not desirable. Other possible instruments are subsidies/tax exemption and contractual requirements.

Abolition of the present exemption from the mineral oil tax would have to be studied in more detail with respect to the consequences of transferring goods from the road to the sea. A CO_2 fund is possible for shipping as well as for other forms of transport.

4.1.7 Quota regulation

It has been decided that aviation is to be included in the EU's quota trading system. A number of factors, including the quota price, will determine how great an emission reduction effect this will have. Quota regulation of international shipping is being discussed, and may be introduced regionally or nationally, for example in the EU or in Norway. Quota regulation is an economic instrument that in principle can ensure cost efficiency and management efficiency in order to achieve environmental policy targets. Because of the administration costs that a purely Norwegian quota system for the entire transport sector would entail, this instrument may not be the most appropriate for reducing emissions.

4.2 Regulatory instruments

4.2.1 Use of direct regulations in the transport sector

Emissions from vehicles are influenced by the fact the EU stipulates requirements through regulations. However, it is difficult in practice to influence the amount of transport and distribution of means of transport through direct regulations. Restricting the travel of individuals through the use of restrictions, personal quotas or similar is very demanding to administer in practice, and would rapidly be seen as an unreasonable incursion into individual freedom of choice.

4.2.2 Government order to market biofuel

As detailed in part D, macro-calculations indicate that the CO_2 tax must be between NOK 1 200 and NOK 3 000/tonne in order to achieve the national emission target in 2020. This is close to the level of the cost of introducing biofuel into the Norwegian market. Operators in the business may thus find it profitable to introduce biofuels without requirements about mix requirements, particularly if they have expectations of high crude oil prices. However, if we want to ensure a substantial introduction of biofuel in the transport sector with a high degree of certainty, a requirement that it be marketed is an effective control instrument. By requiring that 10 per cent biodiesel be marketed in diesel for road traffic, an emission reduction of almost 1 million tonnes CO_2 could be achieved in 2020. An emission reduction of approximately 130 000 tonnes could moreover be achieved by mixing ethanol in petrol for road traffic. The costs associated with this are around NOK 1 000 and NOK 1 300/tonne CO_2 for biodiesel and ethanol respectively. By phasing in flexi-fuel vehicles and E85 (high alternative) an emission reduction of approximately 300 000 tonnes of CO_2 could be achieved at a cost of about NOK 1 400/tonne in 2020. If the marketing requirement is extended to include mixing biodiesel in fuel for the coastal and fishing fleet, construction diesel, railway and aviation (second generation biofuel), the combination is estimated to result in emission reductions of the order of 650 000 tonnes CO_2 at costs of between NOK 800 and NOK 1 300/tonne CO_2.

4.2.3 Government procurement

Pursuant to the Norwegian Act relating to government procurement, account shall be taken of the environmental impact during the planning of each individual procurement. The procurement of transport services and means of transport are examples of important product groups where central government and municipal authorities can require low-emission solutions.

4.2.4 Regulation of parking

This is both an economic and a regulatory instrument. Parking policy is primarily a local responsibility, mainly regulated through the Planning and Building Act. Studies show that regulation of parking in towns and built-up areas in the form of limits to the number of parking places that are made available, pricing and/or taxation of free parking on employer’s premises are effective instruments for curbing private car traffic. Regulation of private parking places and taxation of parking at places of work require statutory amendments. Maximum numbers of spaces for parking can be used more by municipalities, the regional parking policy can be coordinated better, and higher and/or differentiated parking charges can be fixed. The central government can introduce a legal base for the introduction of parking charges on private parking places, tax dispensation on public transport paid for by employer and taxation for the advantage of parking subsidised by employer (being considered). Parking restricted to residents of an area is being tested in Oslo, with positive results. It is also possible to introduce parking cash out, where employees are offered the choice of accepting a taxable cash amount instead of free or subsidised parking places at work.

Parking regulation may be generally oriented or differentiated depending on user, type of vehicle, time period and geographical area. In the transport model simulations a parking charge of NOK 30 is assumed for all work-related travel throughout the country, with a tripling of parking costs for the various travel purposes in the transport model for selected towns, combined with inter-city trains and long-distance buses. An emission reduction of 600 000 tonnes is estimated, and a cost of NOK 3 700/tonne.

4.2.5 Land-use planning

Municipal land-use planning can constitute an instrument for reducing transport requirements, changing the distribution of means of transport and thereby reducing CO_2 emissions. This entails siting residential areas, workplaces, service functions and public transport interchanges in such a way as to reduce transport needs locally and regionally. In the short and medium term, the siting of residential areas and activities is a given, and in practice changes take place only through siting of new buildings and new infrastructure. Such changes will therefore only have an effect towards 2030. Land use that is effective with respect to minimising transport and increasing the share of public transport may require a centralisation of habitation, which may come into conflict with political goals to retain decentralised habitation. It may also come into conflict with other goals. The requirements and possibilities in the Planning and Building Act can probably be followed up by municipal and county governments to a greater extent than they are today. The central government can follow up municipalities, among other things by means of clear guidelines through national expectations. For a further account of the strengthening of land-use planning as an instrument in environmental policy, see the background documentation.

4.3 Information, expertise and research and development (R&D)

Aiming information directly at users has been found to be a good means of influencing the choice of means of transport. Information about the effects of reducing emissions can also to some extent increase the effect of other instruments such as taxation. Information and expertise can for example be an important means of triggering measures associated with ecological driving, active mobility management and coordinated goods transport.

Individual measures in the field of active mobility influence include the following: campaigns to create awareness of own travel behaviour, car-sharing, co-driving, bus travel for employees, regulation of parking at workplaces, flexible working hours, compressed working week, working at home, video conferences, e-trading and transport plans for businesses. For such measures to be effective, support or subsidies for cooperative projects, R&D funding of new solutions and financing of pilot projects will be necessary.

In most cases the Norwegian market alone will be too small to provide adequate incentives for technological development. However, Norway has a number of research and development communities that are developing environmentally friendly technology in the field of transport and communications and other areas. The development of second-generation biofuel is one such example. It is difficult to foresee which technologies or areas will prevail. The allocation of support should be determined on the basis of a broad assessment of all relevant environments, across sectors. Transnova provides subsidies to market-oriented projects in the fields of vehicle technology, fuels and environmentally friendly transport. The Norwegian Research Council provides support for research in the same areas.

5. SUMMARY

The Norwegian Ministry of the Environment gave the Climate and Pollution agency the task of leading Climate Cure 2020 in analysing measures and policy instruments for reaching the targets of reduced CO2e emissions from the transport sector 2.5-4 million tonnes. The transport sector is responsible for the highest levels of CO2e emissions, and has the highest potential for emissions reductions.

Of the measures analysed, the introduction of bio fuels had the largest potential for emissions reductions. It is estimated that phasing in bio fuels would potentially result in emissions reductions of 1.7-1.9 million tonnes in 2020. By developing the public transport sector and increasing car and/or air transport a potential emission reduction of a further 1.2-1.4 million tonnes was found. The estimated costs of the measures considered are mainly less than NOK 1 500/tonne, but some are substantially higher. On the other hand, some measures, such as doubling the share of cyclists on the road, had a significant socio-economic benefit.

In order to implement some of these measures, it is necessary to use various economic and other policy instruments. Some of the measures can be activated through individual instruments and in some cases only through a combination of instruments. For example, use of bio fuel can be brought about by an order to market the fuel (regulatory instrument) or by taxes (economic instrument). Moreover, some of the measures studied will affect one another: for example, a large proportion of low/zero emission vehicles will lead to various measures to reduce passenger car traffic having less effect on emissions. The effects of the instruments will vary through the introduction phases of the measure and on into an operations phase, and will be influenced by market and technological developments, so that there may be a need to adjust the use of instruments along the way.

6. REFERENCES

Klima- og Forurensningsdirektoratet et. al. (2010) Tiltak og virkemidler for å nå norske klimamål mot 2020, www.klimakur.no