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Greenhouse Gas Abatement in the Norwegian Transport Sector

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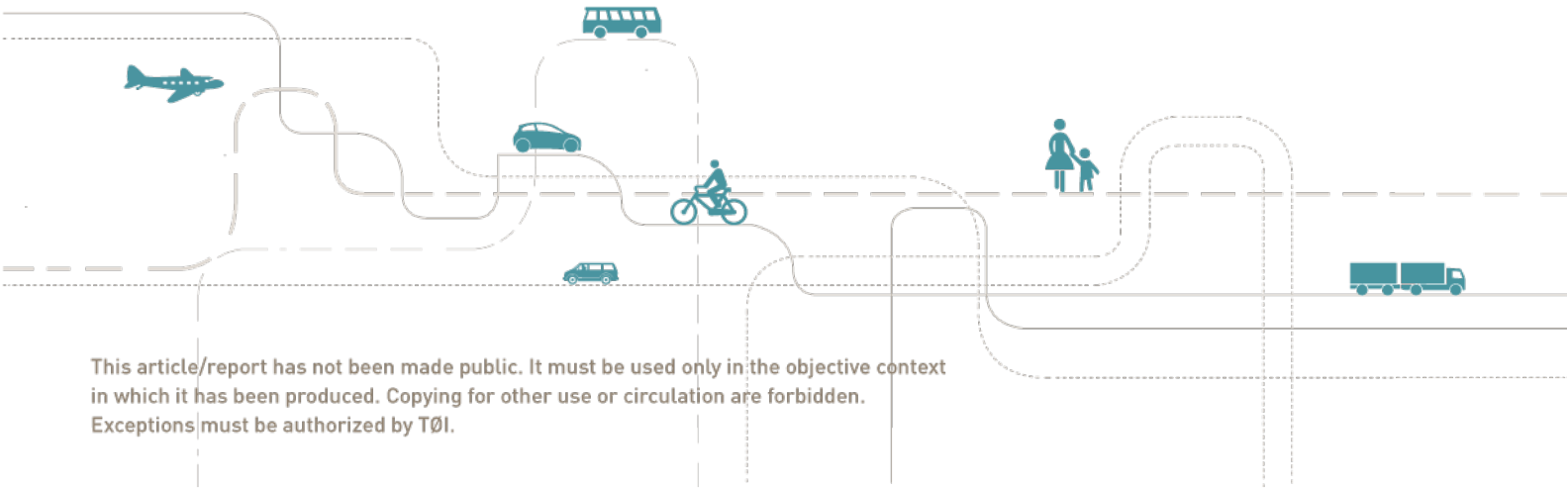

0 Preface

The Swedish Commission on Fossil-Free Road Transport is gathering information on the greenhouse gas (GHG) abatement policy in various countries, focusing on

- fuel and vehicle taxation
- biofuels
- electrification
- vehicle energy efficiency
- concrete measures to improve efficiency in transport
- international repercussions
- private and local government initiatives
- research programmes relevant for choice of instruments and measures
- pending proposals
- ongoing research efforts

This note summarizes the Norwegian experience. The emphasis is on concrete policy measures that have already been implemented on the road passenger transport side, and on their apparent results.

Thanks are due to Per-Andre Torper of the Ministry of Transport of Communications for providing data on the average CO_2 emission rate of new cars, to Bernt Reitan Jenssen of Ruter AS for providing data on public transport ridership, to Per Kågeson of the Swedish Commission on Fossil-Free Transport for his valuable comments, and to Rolf Hagman, Ronny Klæboe, Erik Figenbaum and Jan Usterud Hanssen at TØI for their professional advice and quality assurance.

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Institute of Transport Economics (TØI)

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1 Summary of national policies

The Norwegian government's GHG abatement policy has defined the following overall goals:

- To not only meet the target set for the first period of the Kyoto protocol, but to surpass it by 10 per cent.
- By 2020, to commit Norway to cut global GHG emissions by an amount corresponding to 30 per cent of the country's emissions in 1990.
- By 2050, to achieve total carbon neutrality.
- As part of a possible, ambitious global agreement, to commit the country to national carbon neutrality by 2030 already.

It is, however, understood that not all the cuts in emission need to be made 'at home', i. e. domestically. Up to one half of the cuts could be achieved through the purchase of internationally tradable carbon credits. Deliberations in the Parliament have since sharpened this target, suggesting that no more than one third of the emission cuts should be achieved by international trading.

Emissions from the domestic transport sector (including fisheries, agricultural machinery and other mobile sources, but excluding international air and sea transport) amounted to 17.3 million tonnes of CO_2 equivalents in 2010, representing some 32 per cent of Norway's total greenhouse gas (GHG) emissions. Between 1990 and 2010, GHG emissions from transport rose by 29 per cent. Road transport represents some 59 per cent of the transport emissions.

To reduce these emissions, the central government has pledged, in its 2012 white paper on GHG abatement, to implement new, climate friendly technology and facilitate a gradual transfer to public transport, walking and bicycling. Local governments are expected to reduce the demand for transport by a coordinated land use and environmental policy. Public transport use is to be stimulated through direct subsidies as well as through urban densification.

Among the targets laid down, the following are perhaps the most concrete and verifiable:

- In all the major urban areas, any future growth in travel demand should be absorbed by public transport.
- By 2020, the average CO_2 emission rate of new passenger cars should not exceed 85 g/km.

In the National Budget for 2011, GHG emissions from transport are, in the business-as-usual scenario, projected to rise to 18.7 million tonnes in 2020 and to 18.9 million tonnes in 2030. Road transport would represent 11.9 million tonnes in 2020.

In the so-called 'Klimakur 2020' study, the technical GHG reduction potential in the transport sector (including fisheries) was estimated at 2.5–4.5 million tonnes at the 2020 horizon. Viewed as a target, this translates into a roughly 15-25 per cent abatement ambition compared to the 2010 level. Most measures considered in Klimakur had a calculated cost corresponding to less than NOK 1500 per tonne CO_2, but some were even more expensive.

1.1 Fuel and vehicle taxation

Norwegian automobile ownership and use are subject to important taxes. We may distinguish between (a) fuel tax, (b) vehicle purchase tax, (c) registration tax, (d) road toll, (e) scrap deposit tax, and (f) income tax on company cars.

a. Fuel tax

As of 2012, petrol is subject to a 'road use' tax amounting to NOK[1] 4.73 per litre, a 'CO_2' tax of NOK 0.89 per litre and a general value added tax (VAT) of 25 per cent. Diesel is subject to corresponding tax rates of NOK 3.73, NOK 0.60 and 25 per cent VAT. Needless to say, one NOK of 'road use' tax has exactly the same GHG abatement effect as one NOK of 'CO_2' tax, regardless of how the two are labelled. The purpose of the 'road use' tax is, however, fiscal rather than environmental.

Biodiesel is subject to a 'road use' tax of NOK 1.84 per litre. No 'CO_2' tax is levied on biodiesel.

The petrol and diesel tax rates have been fairly stable over the last 10 years. They do not differ markedly from standard European rates of fuel taxation, although they belong in the upper range. Some argue that, when the Norwegian wage level is taken into account, fuel is relatively cheap in Norway as measured in minutes of work required to buy one litre.

b. Vehicle purchase tax

Vehicles, on the other hand, are more heavily taxed in Norway than in almost any European country, with the possible exception of Denmark. Private cars meant for passenger transport[2] are subject to purchase tax ('engangsavgift') upon their first registration. Imported second hand cars are subject to a graduated purchase tax depending on the age of the vehicle.

Since 2007 the structure of the purchase tax has undergone considerable change, with the purpose of stimulating the acquisition of low carbon vehicles. Up until the fiscal year 2006, the purchase tax consisted of the following three components:

- An amount determined by the weight of the vehicle (kilograms)
- An amount determined by the engine power (kW)
- An amount determined by the engine cylinder volume (litres)

From 2007 on, the cylinder volume component was replaced by a CO_2 component, determined by the vehicle's 'certified' rate of CO_2 emission (g/km) as measured by the standardized EU testing cycle (NEDC). As new types of engine technology were starting to appear in the market (hybrid and electric cars), it was no longer practical to levy a tax that was not technology neutral, but relevant only for 'old-fashioned' combustion engines.

The CO_2 tax curve introduced was progressive, rising more steeply at higher levels of CO_2 emission. It gave an immediate shift in the composition of new car acquisitions, in the direction of lower average certified emission rates. Since CO_2 emission is directly proportional to fuel use, and since diesel engines are generally more energy efficient than those running on petrol, the relative purchase prices shifted markedly in favour of diesel cars. From 2006 to 2007 the diesel engine share of new passenger cars registered rose from 48.3 to 74.3 per cent[3].

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[1] As of 27 December 2012, NOK 1 = SEK 1.168 = € 0.136.

[2] Cars with only two seats and a large cargo room (max 300x190 cm) are classified as vans. For these vehicles, which carry green license plates, the purchase tax rates have been set at 22-25 % of those applicable to passenger cars. Cars registered as taxis are charged 60 per cent of the purchase tax. After three years they can be resold as private cars without penalty.

[3] More detailed information on the shifts in the composition of new vehicles is available from Opplysningsrådet for veitrafikken (OFV). Their annual publication Bil- og veistatistikk provides a useful overview as well as a lot of detail.

In the fiscal years following 2007, gradually increasing weight has been put on the CO_2 component of the purchase tax, so as to steadily strengthen the incentive to buy low emission cars. By 2011, the average rate of CO_2 emission among new cars had dropped by 24 per cent since 2006, and by 2012 by nearly 27 per cent. In the 27 EU countries, the rate dropped by 16 per cent between 2006 and 2011 (Diagram 1).

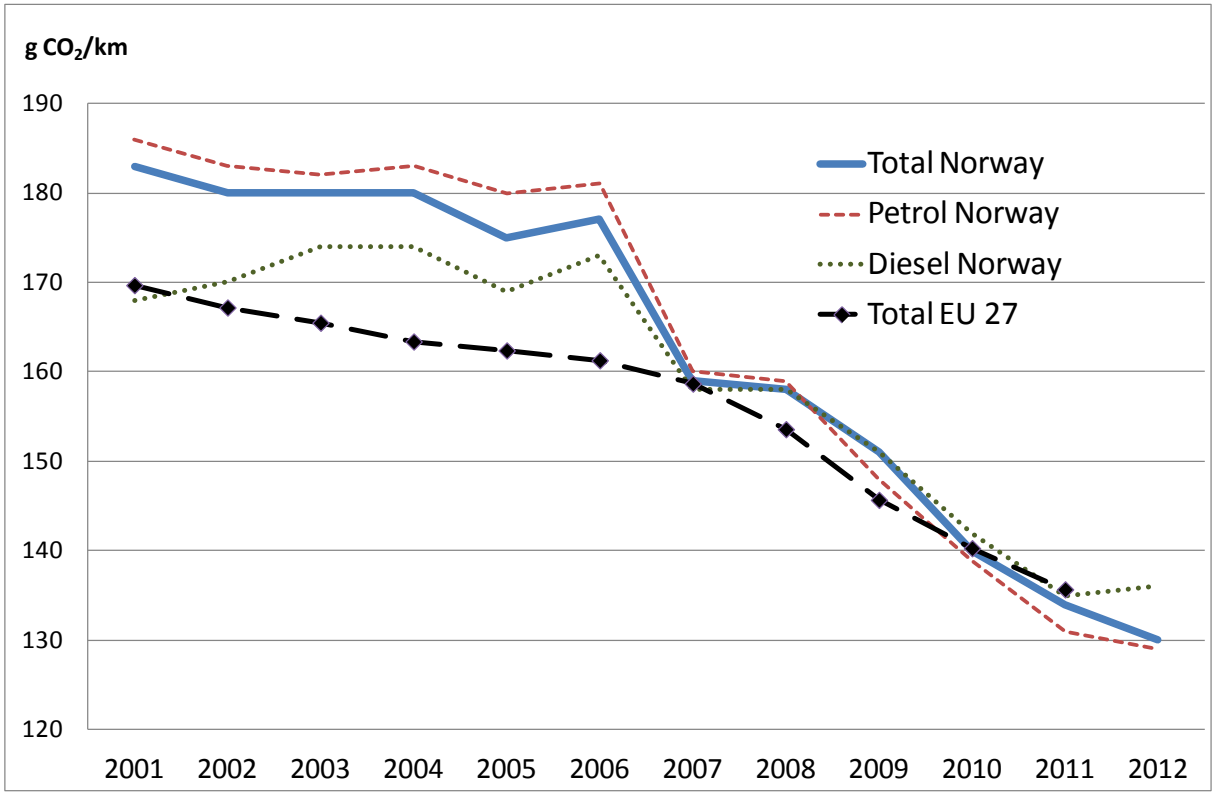

Diagram 1: Average CO_2 emission from new cars registered in Norway, by fuel type, and in EU 27. Electric vehicles are included in total. Sources: Ministry of Transport and Communications, OFV and www.eu.europa.eu.

In 2012, cars releasing less than 110 grams of CO_2 per km actually obtain a subsidy, in the form of a certain deduction in the tax levied on weight and engine power. The deduction is NOK 750 per gram CO_2 from 110 to 50 gram, increasing to NOK 850 per gram below 50 gram.

Between 111 and 130 g CO_2 per km, the tax rate is NOK 750 per gram CO_2, from 131 to 170 g the rate is NOK 756, from 171 to 240 g NOK 1663, and above 240 g NOK 2829. This results in the following CO_2 purchase tax amounts:

Table 1: CO_2 purchase tax component at selected levels of certified CO_2 emission. 2012.

g CO_2/km	50	100	150	200	250	300	350
NOK	-45 000	-7 500	30 120	98 130	196 940	338 390	479 840

Thus, while a vehicle emitting 50 g CO_2 receives a one-time tax deduction of NOK 45 000, a vehicle emitting 250 g is subject to almost NOK 200 000 in extra tax.

Note, however, that this is only one out of four purchase tax components (including the recently introduced, but small NO_x component). For a vehicle weighing 1 000 kilos with an engine of 75

kW, the weight component amounts to NOK 36 890 and the engine power component to NOK 3 150. For a vehicle weighing 2 000 kilos with an engine power of 150 kW, the corresponding tax amounts are NOK 172 840 and NOK 88 075.

The NO_x component is set at NOK 22 per mg NO_x/km. The maximally allowed NO_x emission rate according to the EURO V standard is 180 mg/km, resulting in a maximal one-time tax of NOK 3960.

The background for this tax component is as follows. During the winter of 2010, on account of unusually cold and calm weather, the measurements of local air pollution in the city of Bergen reached an unprecedented level, above the prescribed threshold for toxicity, drawing massive attention from politicians and the media. It was clear that passenger and freight transport, especially those vehicles running on diesel, were the main culprits. The fact that the same level of air pollution arises more or less routinely in Oslo did not draw a corresponding amount of attention.

These episodes, however, alerted the public to the fact that, in terms of local air pollution, present-day diesel engines are far inferior to those of petrol cars, the former having much higher emission rates for NO_x. A debate has started on how to 'trade' GHG emissions against local air pollution. As from 2012, a small NO_x component has been introduced in the purchase tax. This tax is, however, not nearly as 'target effective' as the CO_2 tax, since (i) only the NO_2 part of the NO_x emission is toxic, (ii) under typical rural conditions, the NO_2 concentration stays innocuously low, (iii) the NO_x emission rate varies strongly with temperature and traffic conditions, and (iv) so does the NO_2 part of the NO_x. Some argue that it does not make sense to use a general purchase tax to attack a problem arising only at certain times in certain places. The NO_2 problem has, however, put the continued GHG abatement policy favouring diesel cars under increased pressure. The City of Oslo and the Public Roads Administration both advocated the introduction of 'low emission zones' in the urban centre(s), meaning that diesel vehicles could be deterred from entering either by a financial penalty (toll) or by an outright ban. But the Minister of Transport and Communications later (on 2 October 2012) ruled out the use of such policy measures. In the meantime, however, the sheer public attention drawn to this problem had made the share of new diesel cars sold in the four major cities drop from about 75 to below 50 per cent between August 2011 and August 2012. At the national level, the diesel engine share reached a peak in 2011, with 75.7 per cent, but fell back to 64.3 per cent in 2012. Virtually no economic incentives to combat diesel cars were introduced between these two years[4], so the entire effect is probably attributable to the public attention and commotion that took place.

Since the abolition of the technology dependent cylinder volume tax component, hybrid vehicles have been subject to basically the same tax scheme as vehicles with traditional combustion engines. However, the weight of the electric motor and the battery pack are said not to be subject to purchase tax, whereby a standard 10 per cent deduction is applied when calculating the hybrid vehicle's weight. Similarly, the effect of the electric motor is not counted in when calculating the engine power component. In 2012, some 4.5 per cent of new passenger cars registered were hybrid vehicles, up from 2.8 per cent in 2011.

[4] The NO_x component of the purchase tax is too small to give rise to major shifts in demand.

Vehicles running on at least 85 per cent ethanol are given a lump-sum NOK 10 000 purchase tax deduction. However, few petrol stations offer E85 fuel.

Electric and hydrogen powered vehicles are exempt of purchase tax as well as VAT. Any vehicle with an auxiliary combustion engine for extended range is not considered electric, but as a hybrid.

c. Registration fee

Another element of vehicle taxation is the annual registration fee. Vehicles weighing less than 3 500 kg and equipped with a license plate are generally charged NOK 2 885 per year. Diesel driven vehicles without a factory mounted particle filter are charged NOK 3 360, while motorcycles are charged NOK 1 765, and electric and hydrogen vehicles only NOK 405.

Heavier vehicles are subject to an annual registration fee which depends on the vehicle's weight and suspension system (hydraulic or other).

Whenever a vehicle is resold and reregistered, another lump-sum tax is due. The reregistration fee depends on the vehicle's class, age and weight. The fee decreases with age and increases with weight. As of 2012, passenger cars that were first registered in 2011 or 2012 are subject to a reregistration fee of NOK 8 596 if weighing less than 800 kg, NOK 11 739 between 800 and 1200 kg, NOK 16 880 between 1200 and 1600 kg, and NOK 21 860 above 1600 kg. For cars dating from 2001 through 2008, the corresponding fees are NOK 3 282, 4 684, 6 512 and 8 424. Cars from 2009 and 2010 are charged something in between the 2011 and 2008 levels, while cars from the year 2000 or before are all charged NOK 1 530.

There is thus a significant fiscal 'penalty' on reselling cars younger than 12 years.

d. Road toll

In Norway, unlike Sweden, road tolls are not legally considered a tax, but as a charge incurred by the users of a certain road link. According to the Road Act, tolling may be implemented by decisions by the local government for the purpose of funding road construction or improvement. A large number of tolling projects (some 70) are currently in operation. Although these tolls are not meant as GHG abatement measures, they do serve to increase the cost of travelling by car. In the example given by the newspaper VG on 13 December 2012, a motorist travelling the 857 km from Kristiansand to Trondheim would have to pay appr. NOK 250 in toll, probably adding some 30-50 per cent on top of the fuel cost.

Very few tolling schemes are used for congestion charging or for any other form of marginal cost pricing. The cordon toll ring in Trondheim is the only prominent example, where charges are twice as high (NOK 20 vs. 10) during the rush hours. Congestion charging is an efficient way of combating congestion, but carries – under Norwegian conditions – a no more than a marginal potential for reducing GHG emissions. This is so because a relatively small share of the vehicle kilometres travelled take place under congested conditions. A marginal cost pricing scheme differentiating between vehicles according to their emission rates would have a considerably larger GHG abatement potential.[5]

[5] Steinsland & Madslien (2007) calculated that doubled toll rates around the five major cities would reduce the national CO_2 emissions by 1.3 per cent. Congestion charging would probably have a smaller impact.

e. Scrap deposit

When a new car is registered, the buyer is charged a 'Vehicle Scrap Deposit Tax' reimbursable when the car is delivered to an authorized vehicle scrapping facility. The deposit is meant as an incentive not to leave car wrecks in the street or in the open environment. As of 2012, the deposit payable on new cars is NOK 1 700. The 'reimbursement' collected at scrapping is, however, NOK 2 000, rising to NOK 2 500 in 2013.

The scheme came into effect in 1978. For the single calendar year 1996 the 'reimbursement' was temporarily increased from NOK 1 000 to NOK 6 000, in an attempt to achieve a faster renewal of the car fleet. A total of 227 000 vehicles[6] were scrapped in 1996, against 61 000 in 1995. The registration of new and imported second hand cars rose from 98 000 in 1995 to 147 000 in 1996, 155 000 in 1997, and 141 000 in 1998.

In the following years, however, the turnover was correspondingly lower, so the effect on the fleet's average age was almost as temporary as the policy itself. Demands to repeat the experiment, or to raise the scrap deposit tax more permanently, are being put forward from time to time. Although these policies are being 'marketed' as GHG abatement measures, their potential towards this target is very limited. Since the average CO_2 emission rate of new cars is steadily diminishing, the best one can achieve by intensified scrapping is to move this descending curve a bit to the left, allowing us to reach a certain improvement one or two years earlier than would otherwise be the case. When account is taken of the extra CO_2 emission spurred by increased car manufacturing, the sign of the net effect is questionable.

f. Income tax on company cars

The private use of company owned cars is subject to ordinary income tax. This means that the tax burden incurred by any single beneficiary depends on his/her marginal income tax rate. In Norway, the maximal marginal tax rate on a person's salary is 47.8 per cent. Anyone earning more than NOK 490 000 per annum net of deductions will pay at least 44.8 per cent tax on the margin. Below NOK 490 000, the marginal tax rate is 35.8 per cent.

As of 2012, the annual benefit of using a company owned car is, generally speaking, valued at 30 per cent of the (new) vehicle's list price up to NOK 270 600, and at 20 per cent of the price exceeding NOK 270 600[7]. However, for cars more than three years old as of 1 January, or if the annual distance travelled in the company's service exceeds 40 000 km, the taxable benefit is reduced by 25 per cent. Also, for electric vehicles the taxable benefit is reduced by 50 per cent.

Out of the 4.7 million passenger cars changing hand during 2003-2011, only 1.03 million, i. e. 22 per cent, were new. In Norway, around 40 per cent of all new cars are bought by companies. Taken together, these statistics mean that six out of seven Norwegian households buy their cars second hand (or third, fourth, etc.). The average age of cars scrapped in Norway is 19 years. Hence the annual cost of depreciation and interest incurred by the average car owner is probably not higher than 10 per cent of the list price, in many cases lower, and the total private cost of car

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[6] Of which only 177 000 were actually removed from circulation, having been carrying license plates in 1995.

[7] The median price of new cars sold in Norway exceeds NOK 270 600. The VW Golf 2.0 TDI 140 HP would, e. g., sell for around NOK 300 000 in a 'stripped' version. As of today, few company cars are cheaper than NOK 270 600.

ownership is perhaps only half as high as assumed in the tax regulation. In this perspective, having 'free' access to a company car is by no means free. The beneficiary's incremental income tax could easily approach, perhaps even exceed, the out-of-pocket cost of private ownership to a similar, but significantly older vehicle.

Since the marginal rate of valuation drops from 30 to 20 per cent per annum as the price exceeds NOK 270 600, it may seem that costly company cars are somewhat less heavily taxed than cheaper ones. However, to qualify this one must take into account the strongly progressive purchase tax due, especially the CO_2 component, which serves to render large, energy consuming cars unusually expensive. The current tax rules make it quite costly for employees to receive the benefit of access to such a car.

As of today, few, if any, companies offer their employees electric cars for private use. However, the 50 per cent 'discount' given on electric company cars, which comes on top of the VAT, road toll and purchase tax exemptions, could work as a rather powerful incentive, given that electric cars are otherwise seen as attractive company vehicles. With the market entry of more sophisticated or prestigious models, electric company cars could be facing a rather steep rise in demand during the next couple of years.

1.2 Biofuels

Since 1 April 2010, fuel merchants must ensure that the volume of fuel sold for road transport purposes contain at least 3.5 per cent biofuel in total.

Merchants may choose whether to mix an equal share of biofuel into all the fuel they sell, or to mix a correspondingly higher share into certain parts. In Norway, most petroleum companies achieve the target by mixing up to 7 per cent rapeseed methyl ester (RME) into the diesel sold. Statoil also blend a low share of bioethanol into their petrol.

It was foreseen in the 2010 regulation that, as soon as 2nd generation biofuel fulfilling the sustainability criteria would become available in the market, the mandatory biofuel share would be increased to 5 per cent. However, since doubts have later been raised concerning the climate footprint of biofuel, this regulation has not yet been implemented.

Up until 2009, biodiesel was exempt of the 'road use' tax payable on fossil diesel (NOK 3.20 per litre in 2009). This had led certain large hauliers to implement a programme for massive biodiesel use in their trucks, and a factory in south-eastern Norway had started producing and marketing the fuel. In their budget proposal for 2010, however, the government announced that biodiesel would no longer be exempt from the tax, on the grounds that the climate footprint of biodiesel fuel was uncertain, and that trucks travelling the road by means of biofuel would not meaningfully be exempted from a 'road use' tax.

This proposal sparked a quite heated debate, some reactions[8,9,10] being extremely critical. Certain researchers, however, gave support to the government's argument,[11,12] while also criticizing the

[8] http://www.bellona.no/nyheter/nyheter_2009/Jens_misforstar
[9] http://www.dinepenger.no/regler/biodieselavgift-er-et-dolkestoet-i-ryggen/569033
[10] http://www.vg.no/nyheter/innenriks/norsk-politikk/artikkel.php?artid=592378
[11] http://www.aftenposten.no/meninger/kronikker/article3390006.ece

government for giving out mixed signals to whatever private investors might be willing to commit themselves to innovative, climate friendly solutions.[13]

The possible fabrication and use of biofuels based on boreal Norwegian forest biomass has become an issue of heated debate, within the scientific community as well as publicly. Some argue that since it takes 70 to 100 years for a boreal forest to grow back after harvesting, the use of biofuel based on such biomass is by no means carbon neutral in the short and medium term.[14,15,16] Considering the fact that the need to reduce the GHG emissions globally is an urgent one, the time horizon does matter. Only plants with a relatively short rotation period would qualify as carbon neutral sources of biofuel. Yet, the albedo effect linked to the harvesting of boreal forests may tip the balance in favour of fuel based on such a source: Surfaces that are covered by snow large parts of the year would reflect more sunshine after the forest has been harvested.[17,18] Obviously, the last word has not been said on this fairly complex issue.

In the end, the Parliament decided that biodiesel would be subject to half the 'road use' tax levied on fossil fuel.

1.3 Electrification

Norwegian legislation and taxation provide powerful incentives for the acquisition and use of electric vehicles. These vehicles are exempt of value added tax, vehicle purchase tax, road tolls and public parking charges. They benefit from strongly reduced annual registration tax (see section 1.1 c above) and reduced ferry fares (equal to those payable for MCs). Moreover, they are allowed to travel in the bus lane and may be recharged for free in many public parking lots.

As a result, Norway probably has the largest share of electric vehicles of any country. As of December 2012, there are close to 10 000 electric vehicles on Norwegian roads, i. e. appr. 0.4 per cent of the passenger car fleet. The sales of electric cars have been rising sharply through 2012, reaching a market share above 5 per cent in certain months. In 2012 as a whole, about 2.9 per cent of the new passenger cars registered were electric vehicles, up from 1.4 per cent in 2011.

Electric vehicles are in particularly high demand in the Oslo area, especially in the municipalities west of Oslo, from where the trunk road into the city (E18) is heavily congested during the rush hours. Using the bus lane, electric vehicles may travel at a speed several times higher than the ordinary car.

Certain stakeholders, among them the public transport companies, whose bus lanes are becoming crowded, have been concerned about the fast multiplication of the electric vehicle fleet. Stakeholders on the electrification side, on the other hand, have been asking for stable and

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[12] http://www.ssb.no/emner/01/04/10/rapp_201044/rapp_201044.pdf

[13] http://www.dagbladet.no/2009/11/23/nyheter/innenriks/miljo/miljogifter/statsbudsjettet_2010/9164228/

[14] http://www.transportmiljo.no/aktuelt/klimaeffekt-av-biobrensel/

[15] http://link.springer.com/article/10.1007%2Fs10584-011-0222-6

[16] http://www.frisch.uio.no/cree/publications/Popular_scientific_articles/Debat_SamfOk_Skog_Klima_Holtsmark/Debatt_SamfOk_Skog_BiO_Klima_Holtsmark_2012.pdf

[17] http://www.transportmiljo.no/aktuelt/aapent-landskap-reflekterer-varme/

[18] http://pubs.acs.org/doi/abs/10.1021/es201746b

foreseeable incentives and regulation. To strike a balance between these demands, the Parliament has decided that the present regulation will persist until 2018, or until there are 50 000 electric vehicles registered, whichever comes first.

1.4 Vehicle energy efficiency

The main instrument to enhance vehicle energy efficiency is the CO_2 component of the purchase tax (see section 1.1 b). Since 2006, the energy efficiency of new cars has developed almost exactly like the CO_2 emission rate shown in Diagram 1 – a 27 per cent improvement. Of course the overall energy consumption in road transport will improve at a slower rate, determined by the penetration of new vehicles into the fleet. Norwegian passenger cars have an average lifetime of about 19 years (mean age of cars scrapped).

1.5 General efficiency enhancing measures

The government has launched as its explicit target that, in all the major urban areas, any future growth in travel demand should be absorbed by public transport, bicycling or walking. To the extent that public transport consumes less energy per passenger kilometre than private cars, this intention could be seen as a plan to enhance energy efficiency. It is, however, uncertain whether the set of policy instruments available or foreseen would be sufficient to meet the goal.

At the level of the central government, the most important set of incentives in operation is the so-called '*reward scheme for public transport*' ('belønningsordningen'), established in 2004. Its explicit aim is to relieve congestion and improve the urban environment and health by slowing the growth in motorized traffic and increasing the number of bicyclists, pedestrians and public transport users at the expense of private cars. Counties fulfilling the criteria are entitled to subsidies from the central government. In the fiscal budget for 2012, a total of NOK 411 million has been set aside for this purpose. As of November 2012, NOK 290 million had been awarded to four different counties, for their efforts to improve public transport in the Bergen, Drammen/Kongsberg, Kristiansand and Trondheim areas, respectively.

Another set of instruments to curb automobile use and encourage the use of public transport is *parking regulation.* Many employers offer free parking for their employees. In principle, this fringe benefit is taxable, but in practice, taxing the individual use of parking space is considered too cumbersome. The Ministry of Transport and Communications has proposed a law that would allow cities and municipalities to require that all property owners with more than 10 parking spaces must charge for parking. This would compel large employers to charge their employees and shopping malls to charge their customers. The proposal has met fierce opposition from the business community. One major counterargument is that it would distort competition between neighbouring municipalities, if one of them decides to make use of the provision and the other one does not. Apparently only a nationwide regulation of the sort would work.

Some contend that there is an obvious asymmetry present, in that, while free parking is not taxed, any employer offering his personnel free monthly passes on public transport is required to declare the cost as a taxable part of their salary. Proposals have been made to remedy this by

allowing such fringe benefits to be exempt of income tax. But the Ministry of Finance invariably opposes this on the grounds that it would entail a large drop in income tax revenue.

Efforts are, however, being made to restrict the availability of public as well as private parking in urban centres. In the four largest cities[19], maximal norms for parking space are being imposed on all new office and industrial buildings.

2 Possible international repercussions

The Norwegian policy to further the market introduction of electric vehicles, and its apparent success, has drawn a certain international attention. However, its potential for proliferation is probably somewhat limited. The strength of the economic incentives operating in Norway, in particular the VAT and purchase tax exemptions, is a function of the high initial level of taxation applicable to traditional vehicles with a combustion engine. On account of these taxes, electric vehicles can be sold at fairly competitive prices.

The same high level of taxation has also been quite useful in reshaping the purchase tax into a powerful instrument to lower CO_2 emissions. Consumers tolerate the CO_2 tax because it does not in general result in higher vehicle prices than before.

In terms of technological development, Norway is too small a market for national incentives and regulation to have much impact on the international auto industry. There is no domestic car manufacturing industry.

3 Private and local government initiatives

Trondheim

The most publicized local government initiative is the so-called environmental package ('miljøpakken') of the city of Trondheim. It consists of road and tunnel construction as well as public transport improvement, road safety measures, noise abatement and bicycle facilities. The total budget amounts to NOK 9 656 million, of which NOK 6 642 million will be collected through tolling, while the central government is expected to contribute NOK 1 730 million. The rest would come from the city budget, the county budget and/or through the government reward scheme (see section 1.5).

Some NOK 2 030 million have been set aside for public transport enhancement and NOK 1 300 for bicycle lanes, paths, parking and other facilities. The largest budget share, NOK 4 126, is, however, assigned to road infrastructure improvement, mainly to improve the traffic flow around the urban centre.

[19] Oslo, Bergen, Trondheim and Stavanger.

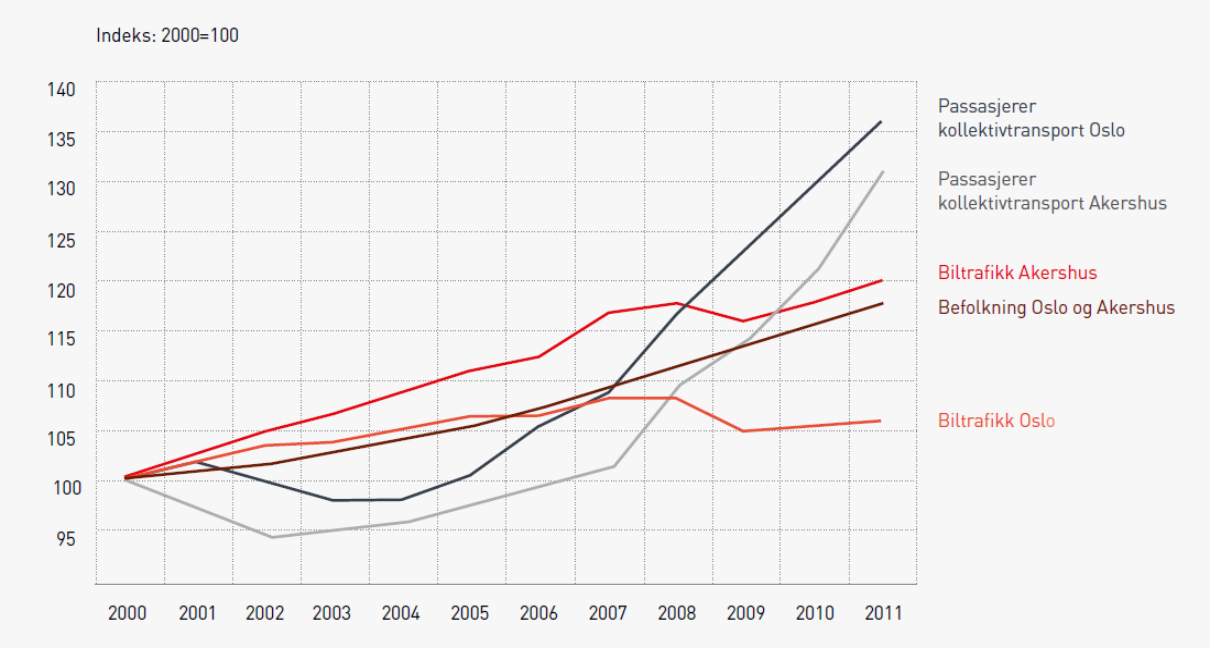

Diagram 2: Development in public transport ridership, private car use and population size in the Oslo and Akershus counties. Source: Ruter AS

Oslo area

In Oslo and Akershus (the surrounding county), public transport ridership has increased markedly over the last few years, while private car use has stagnated (red lines in Diagram 2). This development is due to a complex set of factors, the most important of which are probably the following:

- In 2007, the counties of Oslo and Akershus created a common public transport procurement agency, called Ruter, with the purpose of coordinating, improving and simplifying the public transport supply in the greater Oslo area. A number of improvements and simplifications have already taken place, such as the introduction of a common, electronic fare system.
- The Oslo metro has been upgraded through a complete replacement of the rolling stock. Punctuality has improved and frequency has increased on certain lines. This also applies to the tramway. More bus lines have been put in place. The local railway lines, which had been marred by weak regularity, have undergone important technical renewal work, improving regularity and punctuality.
- Another set of tolling stations have been set up on the western corridor, increasing the total toll to enter the city from the west by 50 per cent.
- The price structure has been amended within the public transport system as well as in the toll ring. Since 1 July 2008, it has not been possible to buy monthly or annual passes for the Oslo toll ring. Every passing is now subject to a marginal cost. Light vehicles pay NOK 21.60 if equipped with an AutoPASS transponder, heavy vehicles are charged a triple rate[20]. In public transport, an almost opposite change took place at almost exactly the same time (1 August 2008): The price of the monthly pass was reduced sufficiently that most commuters choose to buy it, meaning that for a large share of the users, the marginal cost of public transport use is now zero. These one-time changes, introducing a marginal cost for

[20] Note that, unlike in Stockholm, only inbound traffic is charged.

motorists, while abolishing it for many public transport users, have probably served to restrain car use and boost public transport demand.
- Increased congestion, especially on the main arteries into the city, is making it less and less attractive to commute by car.
- The financial crisis, although not felt as severely in Norway as in other European countries, may have contributed to the reduction in car traffic observed from 2008 to 2009.

To curb GHG emissions from public transport vehicles, Ruter has implemented a programme for biogas driven buses in and around Oslo. Also, a small number of hydrogen fuel cell vehicles are currently operating.

Cities of the Future

13 of the largest cities in Norway have formed a cooperation programme called Cities of the Future ('Framtidens byer'). Its purpose is 'to reduce greenhouse gas emissions and make the cities better places to live'. The main idea is expressed like this: 'Cities of the Future are densely built. This means we can walk and cycle instead of using cars, reducing pollution. Fewer cars and roads make more room for bike paths and parks. This makes the cities prettier and makes us healthier. The parks will also help absorb the increasing rainfall expected in the future. […] The Cities of the Future programme will help city municipalities to share their climate friendly city development ideas with each other and with the business sector, the regions and the Government.'

The programme is supported by the Ministry of the Environment.

HyNor

The HyNor hydrogen highway was established in 2003 as part of the Scandinavian hydrogen highway partnership. The highway runs between Oslo and the port of Stavanger. It is part of the Norwegian hydrogen infrastructure, and several hydrogen refuelling stations have been built along the 580-kilometer route.

Norway's first hydrogen fuelling station was opened in 2006 near Stavanger, the second in Porsgrunn in 2007, and two stations were opened in Oslo and Lier in 2009. The official opening of HyNor took place on 11 May 2009 in Oslo.

Originally operated by Statoil, the hydrogen fuelling pumps were taken over by HYOP AS in May 2012.

4 Research programmes

Transnova

The Ministry of Transport and Communications has established an agency, called Transnova, to provide funding for projects that facilitate the implementation of technologies for sustainable mobility. The focus of Transnova is on testing, standardizing, pilot and demonstration projects. Funding from Transnova is therefore most relevant for projects in a phase close to market introduction. Private enterprises, non-governmental organizations, research institutes and local and

regional authorities may apply for funding for projects that will make a contribution to the fast adoption of new and more environmentally friendly technologies or practices.

Transnova is funded by the Ministry of Transport and Communications but managed by the Public Roads Administration. Its annual budget was NOK 50 million in 2009 and 2010. In addition, Transnova administered a one-year funding programme for establishing charging points for electric vehicles. This programme had a NOK 50 million budget, which by 2010 had yielded almost 2000 new charging points. For 2012 Transnova's budget is NOK 74.8 million. The main areas of priority are these:

- Introduction of low CO_2 emission technology and renewable transport energy
- Increased use of environmentally friendly modes of transport, such as public transport, bicycling, walking, sea and rail freight
- Reduced traffic volumes through substitutes to travel or better capacity utilization

During 2010-2012, Transnova supported a trial project on plug-in hybrid vehicles in the Nordic countries. The project assembled user experience as well as a record of technical performance (fuel consumption, emission rates, etc) as measured under realistic Nordic conditions. The average petrol consumption recorded among the trial vehicles was 3.25 litres per 100 km, giving rise to a mean CO_2 emission rate of 78 g/km.[21]

The Research Council of Norway

The Research Council of Norway is administering a small set of research programmes with a bearing on sustainable transport and energy. The most important are RENERGI, SMARTRANS and ENERGIX.

RENERGI has been supporting some 500 projects during 2004-2012, with a total funding exceeding NOK 2 billion. Its aim has been to further the development and use of renewable and sustainable energy.

ENERGIX is its successor. It is a ten-year programme starting formally in 2013. One of its aims is to reduce the emission of greenhouse gases from Norway.

SMARTRANS was started in 2007 with the purpose of developing knowledge on how to reduce distance costs, transfer freight flows from road to sea or rail, and secure a smart, safe, sustainable and efficient transport system. Its annual budget is appr. NOK 22 million.

Having recognized the need for a better coordinated funding mechanism for transport research, the Research Council of Norway has initiated a study to map the most pressing areas of knowledge development. The ten foremost transport research institutions of Norway have, for their part, produced a joint document detailing some of the more interesting research opportunities and needs.

[21] In comparing this rate to the 85 g/km target for new cars as measured by the NEDC testing cycle, one should keep in mind that the average emission rate in real traffic is typically at least 10-20 per cent higher than the NEDC test results.

5 Pending proposals

In January 2012, the high-speed rail study commissioned by the Norwegian Rail Administration ('Jernbaneverket') was presented. A network of high-speed rail (HSR) lines serving the cities of Oslo, Trondheim, Bergen, Stavanger and Kristiansand, possibly also connecting to Stockholm and Gothenburg, was designed, and its costs of investment, maintenance and operation were calculated. The carbon footprint was also given attention, with the interesting conclusion that the carbon debt accumulated during construction would take an estimated 60 years to pay back.

The Rail Administration and the Ministry of Transport and Communications are still considering the matter. Certain conclusions are likely to be drawn in the National Transport Plan 2014-23, to be presented to Parliament during spring 2013.

Another matter of ongoing debate is the development of the so-called Intercity (Rail) Triangle, connecting the cities of Skien/Porsgrunn (southwest), Halden (southeast) and Lillehammer (north) to Oslo, through a radically improved and faster rail service. The calculated cost, although much smaller than for the HSR network, is such as to presuppose a dramatically enlarged government budget for transport investment during the next couple of decades.

The Minister of Transport and Communications recently voiced the opinion that priority should be given to the intercity triangle rather than to HSR.

Another large scale proposal for infrastructure development is the so called ferry-free coastal highway between Stavanger and Trondheim. No less than eight ferry crossings would be replaced by bridge or tunnel. While drastically improving accessibility along its route, the project is hardly compatible with the aim of transferring road transport to sea or rail.

6 Ongoing investigations

The TEMPO project is funded by the RENERGI programme and by 12 user partners, among them the Public Roads Administration. Its aim is to identify and describe the most efficient policy instruments to combat GHG emissions from the Norwegian transport sector. Its main output will be summarized in www.tiltakskatalog.no. A joint endeavour between five research institutions, the project is led by the Institute of Transport Economics (TØI), in close cooperation with CICERO. Its budget is NOK 37.7 million. The project is expected to conclude in June 2014.

7 Summary and discussion

The Norwegian government has set ambitious targets for its CO_2 abatement policy. The transport sector is expected to reduce its GHG emissions by 15 to 25 per cent between 2010 and 2020. Compared to the commonly accepted business-as-usual projection for 2020, the abatement ambition is of the order of 20-30 per cent.

It remains uncertain whether the set of available and politically realistic instruments will be sufficient to meet these targets.

The most promising policy measure applied so far seems to be ***the CO_2 component of the vehicle purchase tax***. From 2006 to 2012, the average CO_2 emission rate of new passenger cars sold dropped by 27 per cent. Although this entire improvement cannot readily be attributed to the CO_2 tax , since several other 'drivers' have been at play simultaneously, it is interesting to note that since 2006 the rate of emission from new cars in Norway has been improving at an about 50 per cent faster pace than in the 27 EU countries.

The average emission rates of the existing car fleet has, of course, so far dropped by only a fraction of the 27 per cent recorded for new cars. However, as new cars continue to replace old ones, the effect will gradually penetrate the entire automobile population. By 2020, close to half the private car fleet of 2012 will have been replaced, and by 2030 almost all of it. As far as private cars are concerned, we can therefore expect an at least 27 per cent improvement by 2030.

An even stronger improvement is foreseeable if the CO_2 tax component continues to receive an incessantly larger weight in the vehicle purchase tax. There is, however, a hurdle. Given that consumers respond to the CO_2 tax as intended, by buying steadily more climate friendly and less heavily taxed cars, the revenue from the purchase tax will shrink. If the government insists on maintaining the level of revenue, it could become an obstacle to a continued sharpening of the CO_2 tax weapon. Or, on the contrary, it could necessitate a quite aggressive policy of gradually 'tightening the bolts'. If and when the target CO_2 emission rate of 85 g/km is achieved, as averaged over all new cars, it would represent a more than 50 per cent drop from the 2006 level.

While the impact of the CO_2 purchase tax component is, in a sense, improving automatically over time, the same is obviously not true of ***the privileges and tax exemptions given to electric cars***.[22] When these cars become too numerous, their right to use the bus lane will have to be abolished. Those who acquire electric cars primarily to gain access to the bus lane will become drastically fewer as the end of this privilege draws nearer. Barring a technological breakthrough that would allow electric vehicles a range comparable to that of petrol or diesel cars, it remains uncertain how competitive electric cars will be from the point where they lose any one of their privileges: bus lane access, VAT exemption, purchase tax exemption, road toll exemption, free parking and/or free public charging. Will the larger variety of models marketed, the improved performance and the price fall due to larger economies of scale be sufficient to outweigh the gradual elimination of subsidies? If not, chances are that the sales of electric cars will taper off as the fleet size approaches 50 000 registered vehicles, corresponding to about two per cent of the car fleet. This severely limits the GHG abatement potential of electric cars in the short and medium term.

Plug-in hybrids may appear more promising in the medium term. The first generation plug-in hybrids that were recently tried out in the Nordic countries came out with an average CO_2 emission rate (78 g/km) well below[23] the NEDC target set for new cars in 2020. Still, their CO_2 abatement potential (compared to non-chargeable hybrids) hinges probably on their electric range being large enough for owners to take the trouble of recharging them whenever possible. There appears, at present, to be two possible directions of technological development – one targeting electric ranges of 20-30 km, the other aiming for 50-80 km. The latter has a clearly higher CO_2

[22] See Hagman et al. (2011) for a more extensive discussion.
[23] The difference is of the order of 20-30 per cent, when considering the fact that emission rates in real traffic are at least 10-20 higher than in the NEDC testing cycle.

abatement potential. With an electric range of 20 km, the fuel savings obtained per charging is of the order of 0.8 litres, at a cost of around NOK 10. To many consumers, this incentive might be too small for climate friendly habit formation. An electric range of at least 50 km would be more likely to elicit such behaviour.

In the longer term, hydrogen fuel cell technology could emerge as the solution to the electric vehicles' range problem. Massive infrastructure investment (fuelling stations) would, however, be required for this type of vehicles to become attractive to the ordinary consumer.

Certain objections have been raised against the electrification subsidies on the grounds that, on the margin, their energy is being generated by thermal plants in Denmark, Germany or Poland. Assuming, however, that the European Union's Emission Trading Scheme (EU ETS) works as intended, there is an unequivocal gain to transport electrification, in that a GHG emission generating activity – travelling – that was previously unchecked, is now brought into the trading scheme. Since the cap on GHG emissions remains the same, no extra GHG unit is emitted as another electric vehicle is allowed to enter the road.

The net gain will, nevertheless, depend on what kind of activity is replaced by the use of an electric car. If bicyclists or public transport users convert to electric cars, or if the privileges enjoyed by electric cars induce additional travel demand, the net GHG abatement gain could turn out to be rather small. There is little solid knowledge on this behavioural issue.

Other than the purchase tax credit given to low carbon vehicles and the tax exemptions and privileges granted to electric vehicles, the Norwegian climate policy instruments applied so far to the transport sector may seem somewhat elusive. It is debatable whether the ***incentives to enhance public transport, bicycling and walking*** are strong enough to reach the target of absorbing all travel demand increase in and around the cities. It remains to be seen if local governments will make decisions in line with this goal. Several recent cases suggest otherwise[24]. The government's ***reward scheme for public transport*** does, however, probably pull in the intended direction, despite the fact that in some of the packages 'rewarded', a large share of the budget is allocated to road construction and improvement, thus facilitating private car use.

Congestion charging is being advocated by some as part of the GHG abatement policy. Its potential is limited, for two reasons. Under Norwegian law, such schemes must be decided locally – where they are notoriously unpopular. Moreover, even if such schemes were implemented wherever appropriate, and succeeded in removing or rescheduling a certain share of the rush hour car trips, these trips represent too small a share of the national emissions to make a significant difference. It is, nevertheless, a highly cost efficient measure. By effectively relieving congestion, it is socially profitable even before considering its CO_2 abatement effects.

Raising the ***fuel tax*** is another measure that is frequently put forward by environmentalists. Some economists give support to this, saying that it makes sense to tax automobile use rather than ownership. While this may appear like a sound theoretical argument, proponents tend to forget the very close link between car ownership and use, which makes it almost immaterial which of the two is taxed. In fact, on account of consumer myopia, a one-time (purchase) tax charged

[24] In planning new hospitals meant to serve two neighbouring cities, rather than locating the hospital near the public transport hub of one or the other, it has become common to choose a location that is 'equally bad' for both, i. e. in an almost uninhabited area between the two urban centres, not easily served by public transport.

upon the acquisition of the vehicle is likely to affect choices more strongly than a corresponding amount of (fuel) tax amortized over the lifetime of the vehicle. The immediate out-of-pocket expenditure is perceived as more tangible and definite than the uncertain prospect of higher monthly costs in some distant future.

A drastic increase in the fuel tax would, surely, restrain demand[25], however with the politically regrettable knock-on effect of also curbing tourism – a rather important source of income in rural Norwegian communities. Other parts of trade and industry would suffer as well. Large increases in the fuel tax is, therefore, only conceivable as part of a joint European initiative.

The role of ***biofuel*** in Norwegian GHG abatement policy is so far a modest one (a 3.5 per cent blend into fossil fuels), and its future role remains uncertain. With the possible advent of new and unquestionably sustainable types of biofuel, the issue may be up for reconsideration.

The development of the ***Intercity Rail Triangle*** around Oslo may seem like a crucial step towards combating the long term increase in private car use – foreseeable on account of population and income growth. However, few investments will be worthwhile until the capacity of the central railway tunnel through downtown Oslo has been substantially expanded. There is growing consensus that priority must be given to removing this bottleneck.

[25] Steinsland & Madslien (2007) calculated that a doubled fuel price, corresponding roughly to a tripled fuel tax, would restrain the car kilometres travelled by about 19 per cent and the CO_2 emissions by 12 per cent.