Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

# Norwegian Transport Towards the Two-Degree Target: Two Scenarios

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*The potential for reducing the $CO_2$ emissions from domestic Norwegian transport within the 2050 horizon has been analysed. Under strongly optimistic assumptions, a 60 per cent decrease compared to the 2010 level may be envisaged. By far the most efficient climate policy instrument so far applied to Norwegian transport is the $CO_2$ graduated component of the vehicle purchase tax, coupled with the substantial tax exemptions and privileges enjoyed by battery electric cars. While the continued and sharpened application of tax incentives may come a long way towards eliminating $CO_2$ emissions from private cars, greenhouse gas abatement in the freight sector is more challenging.*

## Climate policy goals for Norwegian transport

The Norwegian government has set ambitious targets for the reduction of greenhouse gas (GHG) emissions. By 2020, emissions are to be cut to a level 30 per cent below the 1990 benchmark. By 2050, full carbon neutrality is to be achieved. Two thirds of the cuts are to be made domestically, while the remaining third could be compensated for through international trading.

To comply with the two-degree target for global warming, GHG emissions must be cut by an estimated 85 per cent by 2050. In this report, we set out to examine whether this milestone is achievable as applied verbatim to the Norwegian transport sector. Some 32 per cent of the domestic Norwegian emissions are due to mobile sources, and some 26 per cent to transport proper, i. e. when we exclude fishing vessels, agricultural and construction machinery, etc.

To reduce emissions, the Stoltenberg government pledged, in its 2012 white paper on GHG abatement, to implement new, climate friendly technology and mobility patterns. Local governments are expected to reduce the future 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. In all the major urban areas, any future growth in travel demand should be absorbed by public transport, bicycling or walking. By 2020, the average $CO_2$ emission rate of new passenger cars is not to exceed 85 g/km.

## Fuel and vehicle taxation

Independently of climate policy considerations, Norwegian automobile ownership and use have long since been 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. In terms of revenue, (a) and (b) are by far the more important. Taken together, they bring close to US$ 7 billion each year into the public treasury, i. e. almost $ 1 400 per capita.

Petrol is subject to 'road use' and '$CO_2$' taxes amounting to US$ 0.93 per litre (as of 11 November 2013), or $ 3.53 per US gallon. Diesel taxes amount $ 0.72 per litre, i. e. $ 2.72 per gallon. On top of this, a general value added tax of 25 per cent is charged.

Vehicles are more heavily taxed in Norway than in almost any European country, with the possible exception of Denmark. Passenger cars are subject to purchase tax upon their first registration. Imported second hand cars are subject to a graduated purchase tax depending on the age of the vehicle.

In general, the purchase tax is made up by three important components, one depending on the vehicle's weight, a second depending on engine power (kW), and, since 2007, a third determined by the vehicle's 'certified' rate of $CO_2$ emission (g/km) as measured by the standardised EU testing cycle (NEDC).

From 2007 onwards, the $CO_2$ purchase tax component has given rise to an important shift in new car acquisitions, in the direction of cars with lower 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 have 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.

In the fiscal years following 2007, increasing weight has been put on the $CO_2$ component of the purchase tax, so as to strengthen the incentive to buy low emission cars. As of 2013, the following $CO_2$ purchase tax amounts apply (Table A).

*Table A: $CO_2$ purchase tax component at selected levels of type approval $CO_2$ emission. November 2013*

| $CO_2$ g/km | 0 | 50 | 100 | 150 | 200 | 250 | 300 | 350 |
|---|---|---|---|---|---|---|---|---|
| US$ | -15 834 | -7 961 | -1 327 | 5 006 | 17 135 | 34 430 | 57 926 | 81 423 |

Cars emitting more than 110 grams of $CO_2$ per km are subject to a progressively increasing tax rate, while cars releasing less than this actually obtain a subsidy, in the form of a certain deduction in the tax levied on weight and engine power.

From 2006 until 2012, the average rate of $CO_2$ emission among new cars had dropped by 27 per cent, to 127 grams per km (Diagram A). In October 2013, the rate had come down to 118 grams per km, helped to a large extent by the generous privileges granted to battery electric vehicles (BEVs). These cars are exempt of value added tax, vehicle purchase tax, road tolls and public parking charges. They benefit from strongly reduced annual registration tax and reduced ferry fares. Moreover, BEVs 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 31 October 2013, there are more than 17 000 rechargeable vehicles on Norwegian roads, i. e. appr. 0.7 per cent of the passenger car fleet. BEVs constitute the overwhelming majority of rechargeable vehicles, only about 4 per cent being plug-in hybrids (PHEV). BEVs 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.

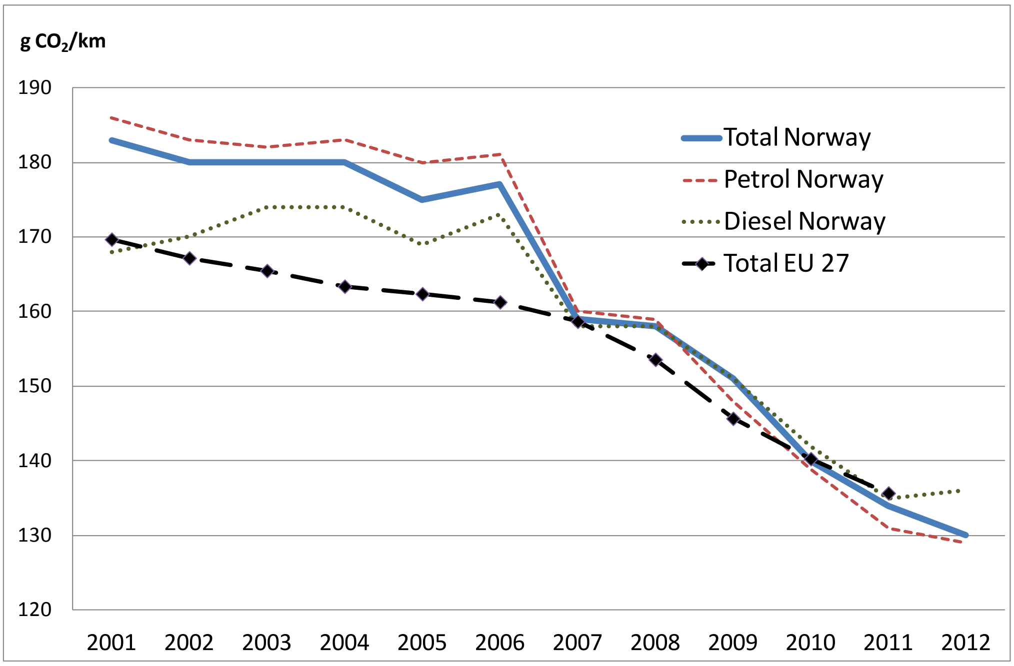


*Diagram A: Average $CO_2$ emission from new cars registered in Norway, by fuel type, and in EU 27. Electric vehicles included in total.*

## Emission scenarios for the 2050 horizon

As an input to the Norwegian National Transport Plan 2014-23, the Institute of Transport Economics (TØI) has developed new, long term travel and freight demand forecasts (Madslien et al. 2011, Hovi et al. 2011). Moreover, an assessment of future energy use and greenhouse gas (GHG) emission rates has been authored by Thune-Larsen et al. (2009).

In the present report, we have combined input from these three publications to produce rough estimates of future GHG emission volumes under a 'reference scenario' as well as a 'low emissions scenario'.

The aim of this analysis has been to elucidate possible paths towards the two-degree scenario, interpreted as an 85 per cent emissions reduction between 2010 and 2050, rather than to describe the most likely course of development. Without disregarding the formidable political and technological challenges involved in achieving emissions reductions compatible with this highly ambitious scenario, we make projections under the hypothetical assumption that many of these difficulties will somehow be overcome.

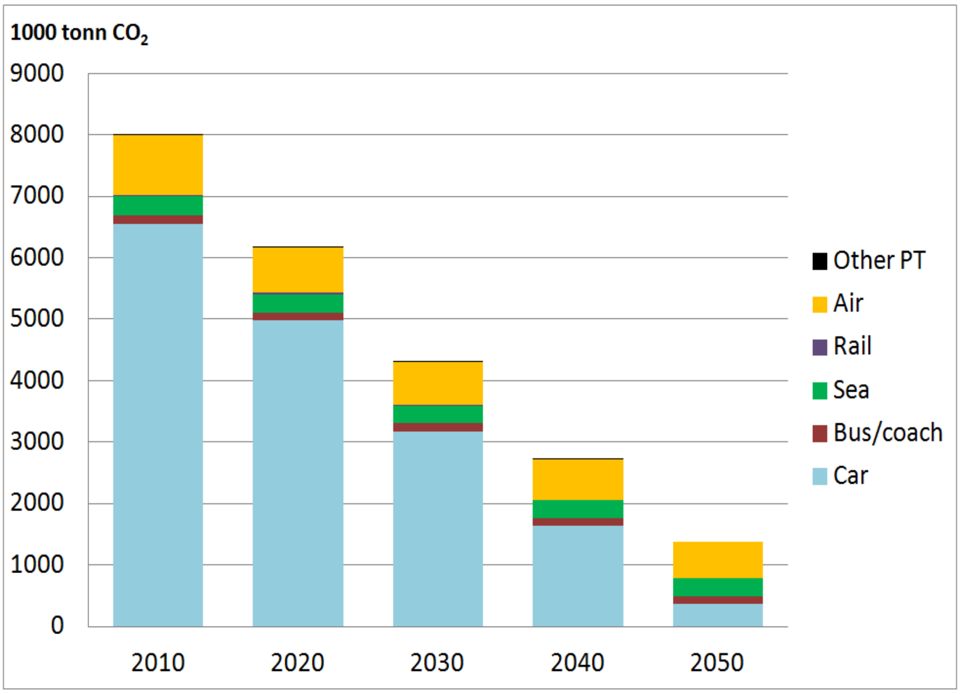


*Diagram B: The low emissions scenario for domestic travel in Norway. Tonnes of $CO_2$.*

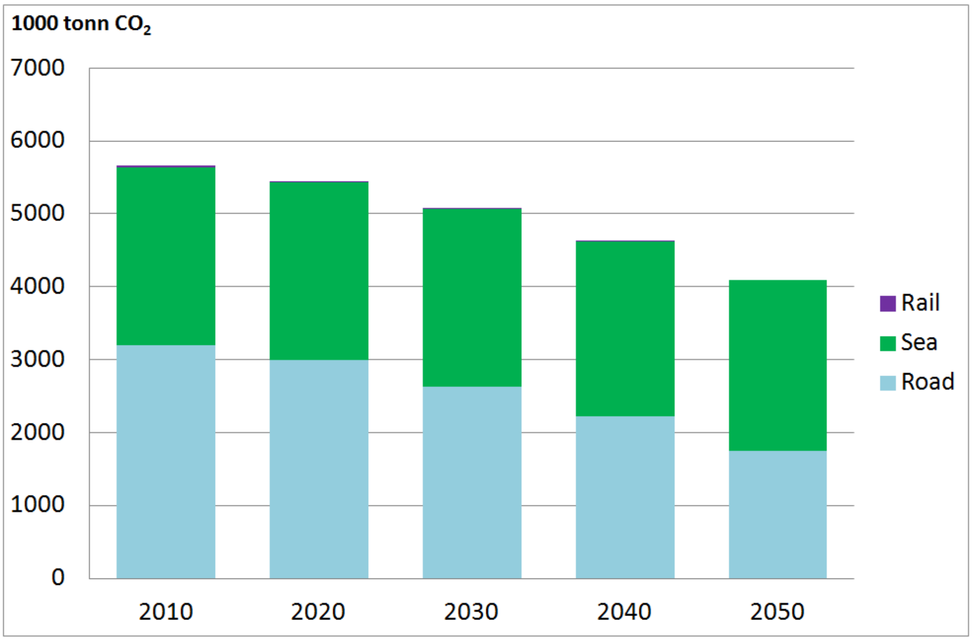


*Diagram C: The low emissions scenario for freight transport on Norwegian territory. Tonnes of $CO_2$.*

In the low emissions scenario, the $CO_2$ emission rate of private cars is assumed to come down by a full 97 per cent between 2004 and 2050. In road freight, an 80 per cent reduction in the emission rate per tonne km is envisioned, while in aviation a 74 per cent drop is regarded as feasible. Emissions from sea freight are assumed to come down by 35 per cent, as measured in terms of grams of $CO_2$ per tonne km.

These fairly drastic improvements will to some extent be offset by the projected, around 50 per cent increase in overall travel and freight demand. In Diagrams B and C we show projected, mode-specific absolute amounts of $CO_2$ emitted under the low emissions scenario.

In this scenario, emissions from domestic travel go down by a full 83 percent. On the freight side, a more modest, 28 per cent reduction is foreseen. Taken together, emissions from Norwegian transport – travel and freight – are, in the low emissions scenario, set to go down by 60 per cent between 2010 and 2050.

At the 2030 milestone, the low emissions scenario projects a 46 per cent emissions reduction from travel and 10 per cent from freight.

## Policy discussion

Although substantial, these emission reductions do not meet the 85 per cent cut compatible with two-degree target for 2050, when interpreted as a uniform emission reduction requirement as applied to every sector of society. Yet, the assumptions underlying the low emissions scenario must be deemed to be fairly optimistic – indeed, some would say heroic.

There is an obvious danger inherent in the construction of such scenarios. While meant to show the potential results of a highly resolute, informed and persistent policy, they might be interpreted by some as a rather plausible image of the future. In such a case they might lead to complacency rather than to political action. This risk is particularly high as long as the scenario specification remains elusive in terms of what policy decisions are needed in order for the scenario assumptions to come true.

Given a roughly 50 per cent increased demand from here on to 2050, even a 33 per cent reduction in emission rates would leave us with a status quo as far as GHG emissions are concerned. To yield an 85 per cent reduction from today's level, emission rates would have to come down by 90 per cent by 2050.

Such a development would qualify as a major achievement in terms of *decoupling*, a term used by the OECD to characterize the breaking of the link between 'environmental bads' and 'economic goods'. If society is unwilling and/or unable to curb economic growth, sustainability must be achieved through pervasive decoupling. The policy of the European Union rests firmly on the paradigm of decoupling, as expressed in the Union's white paper, which states bluntly that 'Curbing mobility is not an option', since 'Transport is fundamental to our economy and society. Mobility is vital for the internal market and for the quality of life of citizens as they enjoy their freedom to travel. Transport enables economic growth and job creation....'

In a paper examining the roll-out requirements for advanced technology vehicles and fuels in the Nordic countries, Lew Fulton and Joel Bremson of the University of California, Davis, describe a set of possible pathways compatible with the two-degree scenario by 2050. Vehicles with conventional combustion engines will have to be entirely phased out, leaving the ground for hydrogen fuel cell vehicles, BEVs and PHEVs.

By far the most efficient GHG abatement measure applied so far in Norwegian transport is the $CO_2$ component of the vehicle purchase tax, coupled with the privileges and tax exemptions given to battery electric cars. The power of these policy instruments is conditioned by the very high initial levels of taxation applicable to private cars. Exemptions from these tax rules represent forceful indirect subsidies, without a single dollar having to be paid out by the public treasury.

While massive privileges apply to BEVs, the tax incentives directed at plug-in hybrid electric vehicles are more moderate. In order for these vehicles to obtain a satisfactory market uptake within the 2020 horizon, stronger incentives may be called for. Since, unlike BEVs, PHEVs do not present any 'range anxiety' problem, their long and medium term prospects for large scale market penetration is quite probably more promising than for BEVs. Most households are unlikely to acquire a vehicle with limited range other than as a second or third car.

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

If and when emission rates from private cars come down as envisioned in the low emissions scenario, effectively decoupling private car use from GHG emissions, the main climate policy argument for curbing private car use disappears.

The challenges to reduce emissions from aviation, and from road and sea freight, remain. Here, the set of policy instruments available to the national government seems, unfortunately, to leave a lot to be desired.