Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

A CO_2-fund for the transport industry: The case of Norway

TØI Report 1479/2016
Author(s): Inger Beate Hovi and Daniel Ruben Pinchasik
Oslo 2016, 37 pages Norwegian language

Heavy transport makes up a large part of the land-based GHG-emissions from the transport sector. Every year, 70 000 trucks emit around 2,5 million tons of CO_2, and pay in over 1,2 billion NOK in CO_2-duties on fuel. A means to accelerate the phasing in of trucks with renewable propulsion technologies is to establish a CO_2 fund for the private sector with the same principles as today's NOx Fund. The revenues of such a fund can be based on a percentage of the current CO_2 duty on fuel. Using these revenues, the fund can provide subsidies towards the additional investment costs for vehicles with renewable propulsion technologies and towards partial coverage of investments in infrastructure, such as filling stations. The analysis in the present report shows that it is most cost effective to support investments in vehicles using biodiesel, but that the availability of sustainable fuel can pose a challenge. A fund should therefore also focus on providing subsidies towards vehicles using more expensive technologies, such as biogas, electricity and hydrogen. Technology for these latter two options is still immature for use on (heavier) trucks. A CO_2 fund may contribute to increasing demand for these technologies and to achieve a critical mass.

Background

As part of a joint implementation towards European climate goals, Norway has committed to cutting GHG-emissions by 40 percent in 2030, relative to 1990. The transport sector makes up over 30 percent of national GHG-emissions, but (with the exception of aviation) falls outside the scope of the European permit system.

In a recent report, the Norwegian Green Tax Committee identifies duties and taxes as the most important tools for achieving emission reductions from transport. In turn, the Confederation of Norwegian Enterprise (NHO) emphasizes the need for both "carrot and stick". One of the more positive measures that NHO proposes is the establishment of a so-called CO_2-fund for the private sector, modelled after the successful NOx-fund equivalent.[1] NHO commissioned the Institute of Transport Economics in Norway (TØI) to evaluate the costs and potential emission reductions of such a CO_2-fund. A summary of this study is presented below.

Emission projections

Based on existing policies and measures, the Norwegian Environment Agency constructed projections on the CO_2-emissions from transport until 2030. In this study, we evaluated some of the projections for heavy trucks and constructed an

[1] The NOx fund, established in 2008, consists of an agreement between the Ministry of Climate and Environment and industry organisations. The fund has so far helped reduce Norway's NOx-emissions by 30 000 tons, with a side effect of also reducing CO_2-emissions by half a million tons.

alternative reference projection based on the forecasts for transport demand in TØI's work on the National Transport Plan 2017-2029. Table S.1. shows projections for the emissions from the industry's transport based on today's policies and measures.

Table S.1. Emissions in CO_2-equivalents from the industry's domestic transport. Figures for 2005 and 2014 come from SSB; figures for 2020 and 2030 are projected by TØI (heavy trucks) and The Norwegian Environment Agency (other categories). Figures in 1000 tons.

Year	Busses	Heavy trucks	Vans	Construction Equipments	Coastal shipping	Fishery	Total
2005	475	2 221	1 325	1 300	2 017	1 350	8 688
2014	462	2 404	1 542	1 691	1 591	1 135	8 825
2020	604	2 587	1 696	1 874	1 945	1 534	10 240
2030	627	2 914	1 831	1 858	1 914	1 441	10 585

With the assumptions we used, emissions from the industry's transport, including busses, are set to rise from roughly 9 million tons CO_2 in 2014 to 10,6 million tons in 2030, based on today's policies and measures. These figures are, however, somewhat uncertain. In particular, this applies for domestic shipping, for which historical SSB figures show emission reductions between 2005 and 2014, while domestic shipping actually increased (Farstad, 2016). For heavy trucks, the primary focus of this report, emissions will rise from 2,4 million tons CO_2 in 2014 to 2,9 million tons in 2030.

Renewable technologies

According to the Norwegian Petroleum Institute, Norwegian sales of biofuels for road transport currently amount to roughly 170 million litres annually. About 90% of these sales consists of biodiesel, while roughly 10% consists of bioethanol. In addition, biogas sales are equivalent to 45 million litres diesel, and biogas is mainly used in fleets of busses and heavy trucks. These sales make up about 7,6% of today's fossil diesel sales.

In this study, we have limited ourselves to truck transport, which makes up the largest part of road transport. We considered four renewable fuels and propulsion technologies as alternatives to conventional combustion technologies and fossil fuels: 1) biodiesel, 2) biogas, 3) electricity and 4) hydrogen/fuel cells.

Adapting vehicles for the use of biodiesel requires relatively small adjustments at a relatively low additional cost. Adapting vehicles to biogas requires somewhat larger adjustments at considerably higher additional costs. Technologies based on electricity and hydrogen are not yet mature for heavy transport, and require the individual adjustment of vehicles. This makes that the additional costs for these technologies are still high at present. For this study, data on additional costs was collected confidentially from manufacturers and different types of transport firms.

Besides the adaptation of rolling stock, a successful phase-in of alternative fuels for trucking requires the development of infrastructure for filling stations. This applies especially to quick-charging points (and charging through induction) for vehicles running on electricity. Hydrogen and biogas also lack a sufficient fuel distribution infrastructure, while there are currently only few terminals for pure biodiesel (only 5-6 locations in Norway). This means that developing a national distribution infrastructure for any alternative technology will entail significant costs. Data on investment costs for (renewable) filling stations was collected from suppliers of several fuels and Enova.

The fund's set-up

The CO_2-fund is proposed to start in 2018 and to run for ten years. Its proceeds depend on the participation rate, the fuel use of the funds' participants, and the per litre duty. In our analysis we assumed a participation rate of 25% in year one, up to 80% in the funds' final year.[2] The duty was set to approximately 0,80 NOK, or 70% of the current per litre CO_2-duty, and the fuel use of participants was based on sales and emissions predictions for heavy trucks in Table S.1. Our analyses took into account that the fund's proceeds are used on subsidies that lead to lower diesel sales, which in turn reduces the duty base for the fund in upcoming years. The magnitude of this effect depends on which technologies receive subsidies, and is elaborated upon in our analysis.

In our analyses, we assumed that only part of the additional/investment costs is covered by the fund, or respectively 80% for rolling stock and 50% for infrastructure (filling stations). Additional costs are calculated relative to vehicles with conventional combustion engines. Fully in line with the NOx-fund, increased operational costs are not covered by the fund. Given that firms have an incentive to participate in the fund, but not necessarily to also pursue investments, alternative coverage schemes should also be considered. One could for example decide to also cover higher operational costs or to take into account the higher depreciation rates that are caused by (presently) underdeveloped resale-markets.

Six scenarios

We constructed six scenarios in which we analysed the costs and effects of a possible CO_2-fund. Four of the scenarios were based on 'extremes' with full reliance on either biodiesel, biogas, electricity or hydrogen/fuel cells. In the fifth scenario we allocated the share of the subsidies going to rolling stock as follows: 50% to biodiesel vehicles, and the remaining part equally dispersed with 16,67% to hydrogen, electricity and biogas respectively.

In the last scenario, we took into account the maturity of electric and hydrogen technology: During the first years of the fund, most emphasis is put on subsidizing biodiesel vehicles and infrastructure, with some of the funds' proceeds going to investments in electric and hydrogen infrastructure. After a few years, emphasis shifts from biodiesel to electric and hydrogen; first to lighter trucks, later also to heavier ones.

In addition, the shares of the funds' proceeds going to infrastructure subsidies is chosen such that in all scenarios, sufficient infrastructure is constructed for all applicable technologies. This assumption is important, as will be discussed in the results summary. Given the characteristics of the different technologies and filling stations, we assumed that a sufficient infrastructure consists of:

- Ca. 60 hydrogen stations
- Ca. 140 biogas stations
- Ca. 700 biodiesel stations
- Ca. 500 electric charging points.

2 Based on consultations with NHO and experiences of the NOx-fund.

Figure S.1. shows the yearly CO_2-reduction in 1000 tons, compared to the reference projections for heavy trucks.

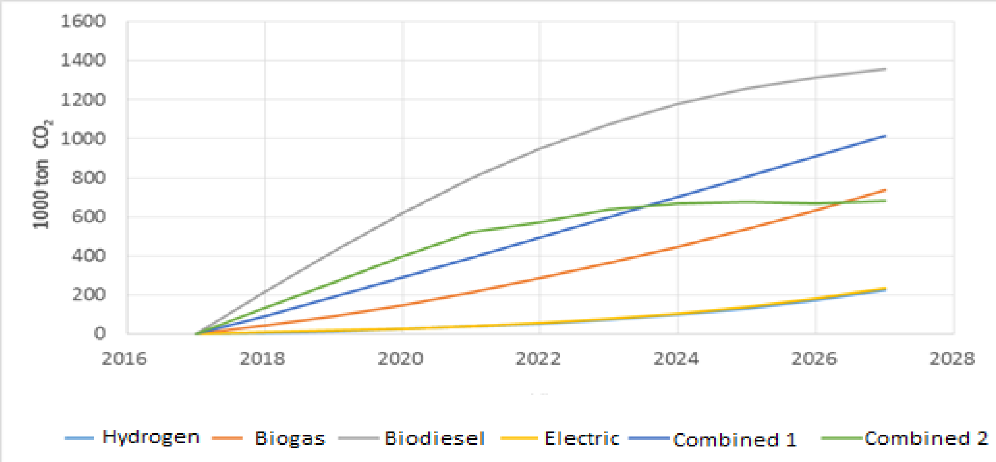

Figure S.1. Yearly CO_2-reduction in 1000 tons compared to the reference projections for emissions from heavy trucks for the period 2017-2027.

The figure shows that the yearly reduction increases year by year during the funds' lifetime, and that full reliance on biodiesel results in a CO_2-reduction of 1,4 million tons annually by 2027 (the funds' last year) relative to the reference projections for emissions from heavy trucks. Full reliance on biogas, in turn, results in roughly half this effect. In "Combined 1", a CO_2-reduction of about 1 million tons in 2027 is achieved, while the reduction in "Combined 2" amounts to 700 000 tons. In this scenario, yearly reductions go down after some years, as more emphasis is put on subsidizing more expensive technologies like hydrogen and electricity. Finally, full reliance on electricity or hydrogen leads to CO_2-reductions of about 200 000 tons in the funds' final year.

After 2027, annual CO_2-reductions start to decrease year by year until 2048, when the last vehicles to have received subsidies reach the end of their lifetime. Annual CO_2-reductions decrease because the driving distance of a vehicle is generally highest in the first year of its use, and then decreases over time. Nevertheless, the fund still achieves CO_2-reductions in the 20 years after its final year: the accumulated CO_2-reduction in the scenario with full reliance on biodiesel is for example 13 million tons in 2027, but 18 million tons in total. In other words, almost a third of the CO_2-reduction materialises after the fund has ceased to exist. Similar results are found for the other scenarios.

Figure S.2. shows the annual CO_2-reductions from subsidies towards the development of infrastructure, a reduction potential that comes on top of the CO_2-reduction from subsidies to rolling stock in figure S.1.

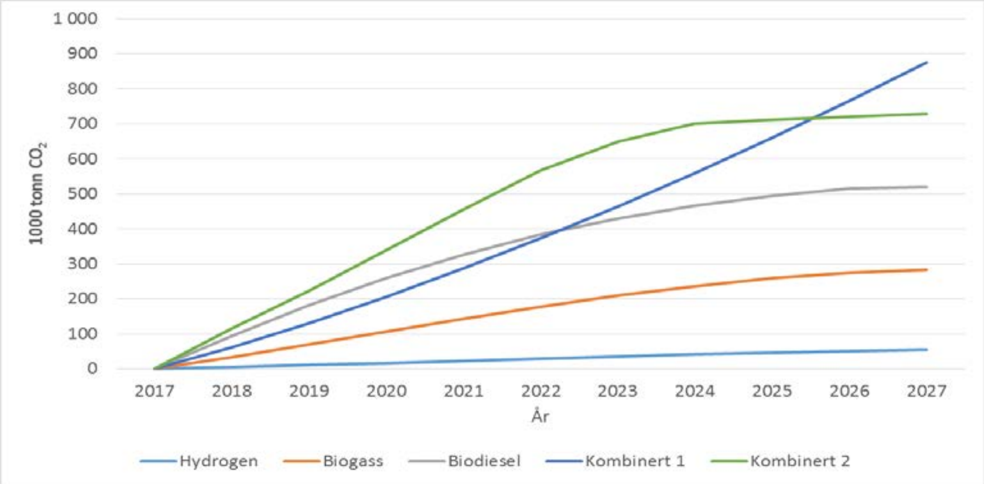

Figure S.2. Yearly CO_2-reduction in 1000 tons as a result of subsidies to infrastructure, relative to the reference projections, for every scenario in the period 2017-2027.

Subsidies towards the development of infrastructure lead to CO_2-reductions when better developed distribution networks for renewable fuels are also used by passenger cars or other unsubsidized vehicles. The figure shows that the CO_2 reduction potential is highest for the two combined scenarios. [3] An important driver of this result is that the combined scenarios require the development of sufficient distribution networks for not just one technology (such as hydrogen), but for several technologies. Consequently, the number of constructed filling stations is higher than for the scenarios with full reliance on only one technology.

Concluding remarks

Altogether, our analysis indicates that it is most cost effective to allocate subsidies to vehicles using biodiesel, but that the availability of sustainable biofuels may pose a challenge. This is, however, a critical assumption on which the potential for emission reductions in many cases may depend. A potential CO_2-fund should therefore also allocate subsidies to more expensive technologies based on biogas, electricity, and hydrogen. Technologies for these latter two options are still immature for use on heavier trucks, but a CO_2 fund may contribute to increasing demand for these technologies and to achieve a critical mass. In our analyses, we have focused on heavy trucks and the potential for CO_2-reductions for truck transport. Should a CO_2 fund also include other segments of the transport market, its duty base, the number of measures, and the CO_2 reduction potential could all increase considerably.

Estimates on CO_2-reductions from the construction of infrastructure are somewhat more uncertain and should be interpreted with more caution. Particularly for electrical infrastructure, it is uncertain to what extent the development of infrastructure can lead to additional CO_2-reductions.

[3] Note that we haven't been able to estimate CO_2-reductions from development of infrastructure for electrical charging. Consequently, the figure may underestimate the CO_2-reduction for the scenarios "Electricity", "Combined 1" and "Combined 2".