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

Themes: «Godstransport og logistikk» & «Trafikkens energy-, klima- og miljøforhold»

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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 – which falls outside the scope of the European permit system – makes up over 30 percent of national GHG-emissions, with heavy road transport being responsible for a large part of land-based emissions. 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.

In a recently published 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 transport industry, modelled after the successful NOx-fund equivalent.[1] In return for committing to greening their fleets, participants in a CO_2-fund would pay a lower per litre fuel duty than non-participants. The proceeds from these duties would then be earmarked for subsidies towards the (partial) coverage of the additional investment costs for more environmentally friendly rolling stock, but also towards the construction of required infrastructure (fuelling stations). 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 tentative summary of the study is presented in this abstract.

Emission forecasts

For our analyses, we worked with emissions forecasts for different transport segments, based on existing and adopted policies and forecasts for transport demand. CO_2-emissions from the industry's transports, including busses, are set to rise from roughly 9 million tons CO_2 in 2014 to about 10,6 million tons in 2030 (see Figure 1). As road transport (particularly heavier transport) forms the largest source for these emissions, our analysis primarily focused on analysing the effects of a CO_2-fund covering these segments.

Methodology, analysis and approach

The reasoning behind NHO's proposed CO_2-fund is to use subsidies to accommodate shifts from fossil fuel dependent rolling stock and infrastructure to more renewable technologies. In this study, we considered four alternative fuel technologies: 1.) biodiesel, 2.) biogas, 3.) electricity, and 4.) hydrogen/fuel cells.

We took into account vehicle-specific characteristics (fuel use at average loads, lifetime, distribution of driving distance over lifetime), fuel-specific characteristics (emission factors), requirements for the construction of sufficient fuel distribution infrastructure (costs, minimum number of fuelling stations required for each technology), and price and market developments (additional costs compared to ordinary diesel vehicles, price developments during the funds'

[1] The NOx fund was established in 2008 and consisted of an agreement between the Ministry of the Environment and 15 industry organisations. After some adaptations, the NOx fund has so far helped reduce Norway's NOx-emissions by 30 000 tons, with a side effect of also reducing CO2-emissions by half a million tons.

operation).[2] Data was collected from a variety of sources, and where possible double-checked against other sources.[3]

In consultation with both NHO and the NOx-fund, we arrived at a base set-up for the CO_2-fund (level of the duty, participation phase-in, and different choices for the distribution of subsidies). In addition, it was decided that subsidies would cover up to 80% of the additional costs for investments in new vehicles running on alternative fuels (such subsidies are more cost effective than subsidising the modification of existing vehicles). We also assumed that subsidised vehicles would one-on-one replace vehicles with conventional combustion engines. Subsidies towards alternative infrastructure were set to cover up to 50% of investment costs. Other additional costs (e.g. higher operation or maintenance costs) are not covered by the fund.

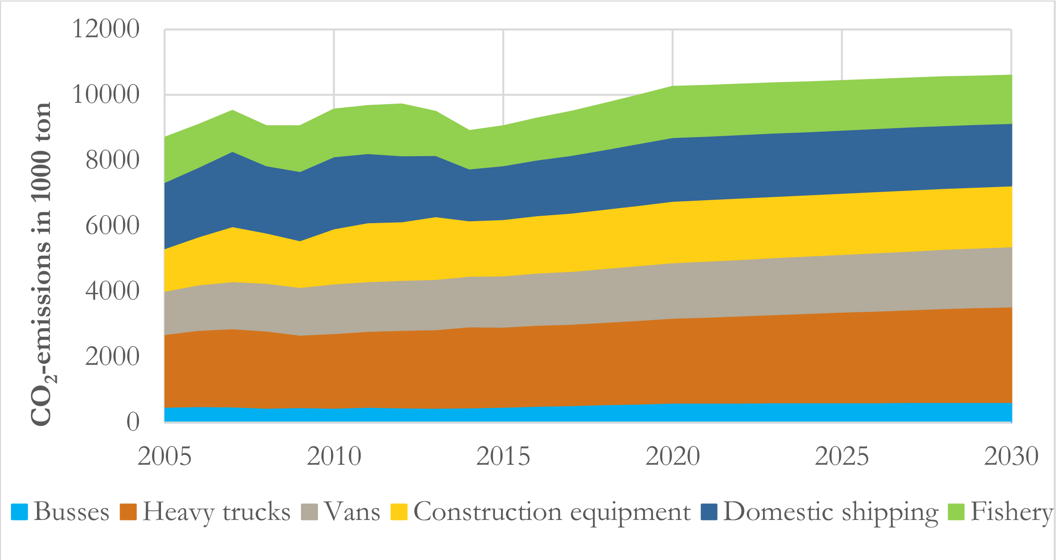

Figure 1: Domestic emissions in 1000 ton CO_2-equivalents from the industry's transport.

The funds' 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.[4] The duty was set to approximately 0,90 NOK, or 80% of the current per litre CO_2-duty, and the fuel use of participants was based on sales and emissions predictions, corrected for the funds' own effect in different scenarios (see next section).

The CO_2 reduction potential from the replacement of trucks depends on which measures are chosen, how many measures receive a subsidy, and to which segments of the transport sector these subsidies are allocated. Over time, the CO_2-reduction will for example be larger for subsidies given to long-haul vehicles than for subsidies given to local distribution vehicles. It is also challenging to predict when exactly certain technologies are ready for large-scale implementation. For this reason, we constructed several scenarios, outlined below.

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[2] Costs for adapting rolling stock differ considerably. Switching to biodiesel requires mostly small adjustments at relatively low cost, while the extra costs for switching to biogas are considerably higher. Currently, the market for trucks running on electricity or hydrogen is still small, resulting in high extra costs and individual orders.

[3] Data on important assumptions, such as additional costs compared to conventional vehicles and infrastructure, was collected (confidentially) from producers, transport companies, firms using vehicles running on renewable fuels, several infrastructure suppliers, internal experts, and subsidy organisation Enova. As there is reason to believe that the extra costs of mainly electrical- and hydrogen vehicles will drop, estimates were corrected over time.

[4] Based on consultations with NHO and experiences of the NOx-fund.

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 respectively hydrogen, electricity and biogas.

In the last scenario, we took into account the maturity of electric and hydrogen technology: In the first years of the fund, most emphasis is given to biodiesel vehicles and infrastructure, with some facilitation of electric and hydrogen infrastructure construction. After a few years, emphasis shifts from biodiesel to electric and hydrogen, first to the lighter trucks, but later also the heavier ones.

For all scenarios, we took into account that the funds' subsidies will reduce diesel consumption in the years going forward, and thereby also reduce the duty basis in the years going forward to a larger or smaller extent. 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.

Results: subsidies to rolling stock

If one *only* looks at the effects of subsidies to rolling stock in Figure 2, the largest CO_2-reduction is achieved in the scenario with full reliance on biodiesel. Depending on emission accounting (do biofuels reduce emissions by 60% or 100% compared to ordinary B7-diesel)[5], the CO_2-reduction in 2027, the funds' final year, is respectively 0,9 million or close to 1,6 million tons relative to the reference forecasts (i.e. 32% or 55% respectively). This is due to the relatively low additional costs of biodiesel vehicles, which makes that the CO_2-reduction per invested NOK also is highest in this scenario.

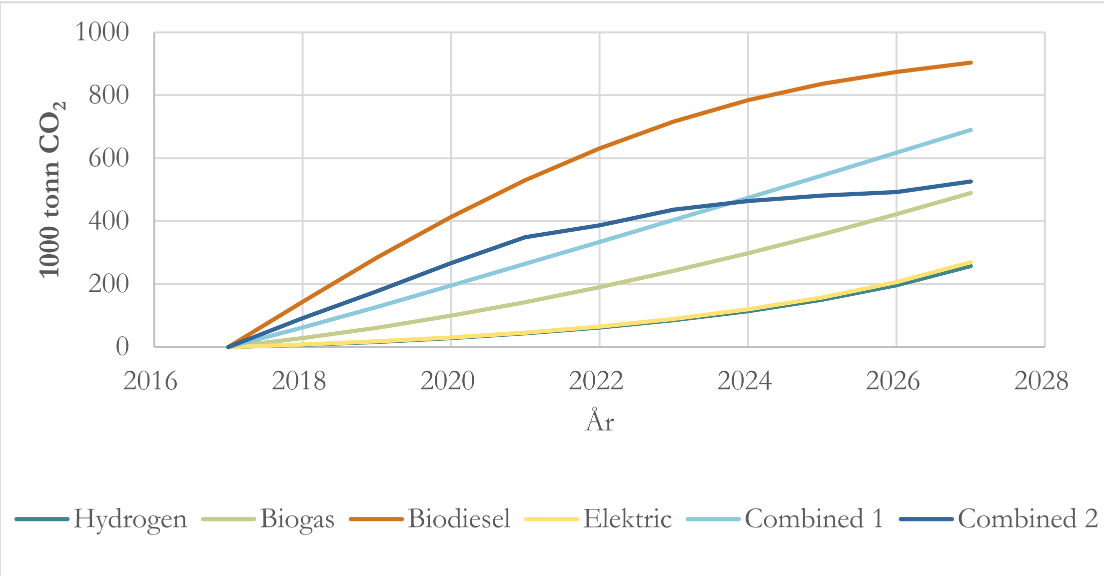

Figure 2: Yearly CO_2-reduction from subsidies to rolling stock, relative to the reference forecast (in ton CO_2).

[5] The Norwegian Environmental Directorate assumes that biofuels reduce emissions by 100% compared to fossil fuels. As a final report for this project is not yet published, this abstract presents results using a more conservative value of 60 percent.

The CO_2-reduction in both combined scenarios is also considerable. The reason for these scenarios doing better than the 'extremes' for biogas, electric, or hydrogen is that, again, a considerable share of subsidies is allocated to biodiesel vehicles. Relying on electric and hydrogen vehicles is relatively expensive, especially in the funds' early years. In the funds' last year, full reliance on electric or hydrogen vehicles results in a CO_2-reduction of around 7,5 percent of the reference emission forecasts, while relying on only biogas results in roughly double that effect. At the same time, it is important to note that the funds' effects do not cease in its last year. In most scenarios, half of the accumulated CO_2-reductions materialises after the funds' settlement (see figure 3).

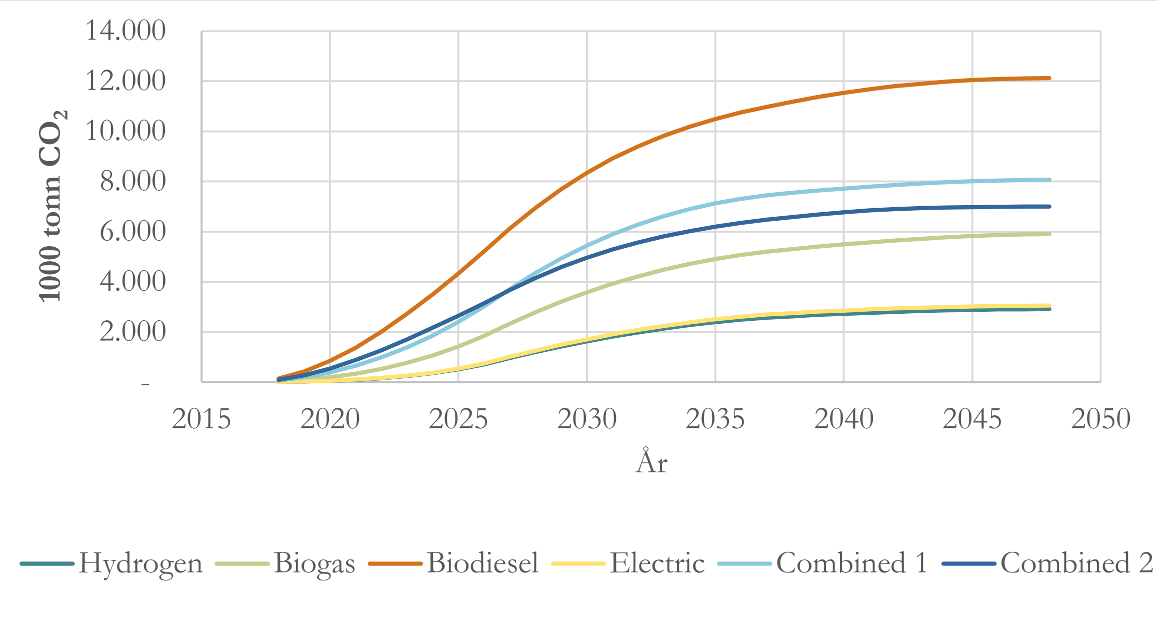

Figure 3: Accumulated CO_2-reduction relative to the reference forecast (in ton CO_2).

Results: expanding the duty base

We also analysed the effects of expanding the funds' duty base by phasing in membership from several other transport segments (domestic shipping, fishery, and smaller transportation vans). These parties have an incentive to participate, as the duty rate of the fund is lower than the CO_2-duty they would otherwise pay. Although one could consider using these extra proceeds on subsidies to these different segments as well, we restricted our study to subsidies towards heavy road transport in the second combined scenario. In this scenario, expanding the funds' duty base increases the funds' proceeds from NOK 220 million to NOK 719 million in the first year. The effect of these extra proceeds results in a CO_2-reduction of 2,3 million in the funds' last year, more than double the reduction in the scenario with full reliance on biodiesel.

Results: subsidies to infrastructure

Subsidies towards expanding alternative infrastructure lead to additional CO_2-gains if this infrastructure is also used by passenger cars or other vehicles that have not received subsidies from the CO_2-fund.[6] Ideally, one would therefore compare the different scenarios based on CO_2-reductions resulting from both rolling stock and infrastructure subsidies. This distinction is material, as the 'extreme' scenarios only require the construction of sufficient infrastructure for one technology, while the combined scenarios require the development of sufficient

[6] Vehicles receiving subsidies have already been accounted for; including them again would result in double counting.

infrastructure for respectively four or three technologies. This means that in the combined scenarios, a smaller share of the proceeds remains available for subsidies towards rolling stock.

Nevertheless, adding together the CO_2-reductions from both rolling stock and infrastructure is difficult. Estimates on the CO_2-effect of constructing fuelling stations are much more uncertain than estimates on the CO_2-reduction from replacing conventional diesel vehicles by vehicles using different technologies. For biodiesel, biogas and hydrogen infrastructure, we constructed estimates on possible CO_2-reductions, but it is important to emphasize that we have not been able to reach reliably estimate the CO_2-gains from constructing electrical charging stations. Possible gains from expanding electrical infrastructure have therefore not been included in our analyses, which is important to take into account when interpreting the results below.

Figure 4 shows rough estimates for the additional CO_2-gains from the construction of infrastructure in the different scenarios. Note that not being able to estimate potential additional CO_2-gains from expanding the network of electric chargers has implications for both the combined scenarios and the electricity 'extreme'. Both combined scenarios and the biodiesel scenario are characterised by a relatively high number of new infrastructure constructions, while in the hydrogen and biogas extremes, the number of additional fuelling points is relatively low.

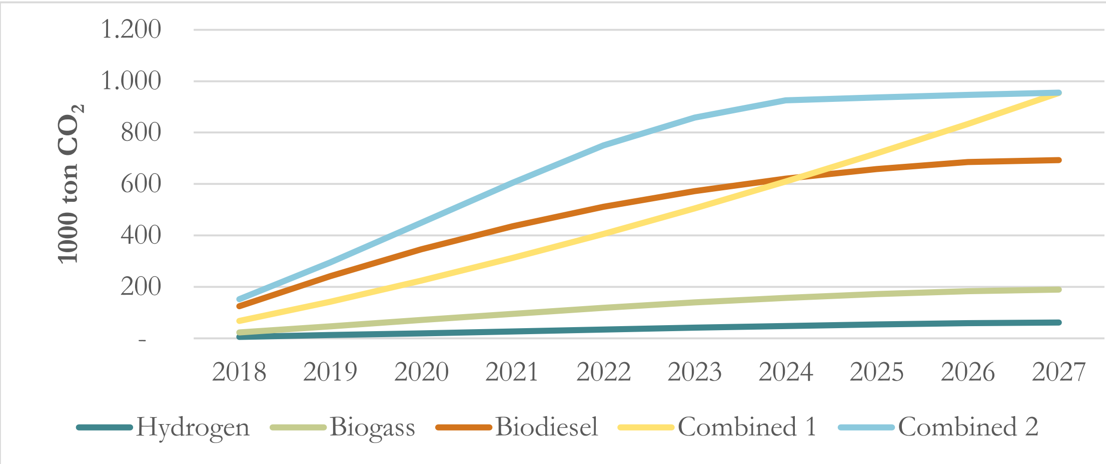

Figure 4: Yearly CO_2-reduction from subsidies to infrastructure, relative to the reference forecast (in ton CO_2).

Final remarks

All in all, adding up the potential CO_2-gains from subsidies to both rolling stock and infrastructure would at this point lead to totals that are somewhat distorted (possible CO_2-gains from expanding electrical infrastructure are not included) and more uncertain relative to the estimated CO_2-gains from only the subsidies to rolling stock. Nevertheless, our results suggest that subsidies to biofuel measures are relatively cost-effective. Two final remarks are in order: in our analyses, we did not impose restrictions on the availability of sustainable biofuel(s). If biofuels are not sufficiently available, this assumption is critical, and steers the potential for CO_2-reductions. Secondly, discussions about external effects, sustainability, and ethics of biofuels remain, presenting possible barriers to an implementation on a much larger scale.