The Norwegian vehicle electrification policy and its implicit price of carbon

Lasse Fridstrøm, TØI

ECTRI TG ECOPOL webinar, January 28, 2021
In 2020, 75 percent of all new passenger cars in Norway were electric (i.e., BEVs or PHEVs).

BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle; ICE = internal combustion engine
Norway: 75 percent cut since 2001

Average NEDC rates of CO₂ emission from new passenger cars

WLTP cycle used in 2020
Vehicle electrification in Norway is faster than anywhere in the EU. Why?

![Energy technology market shares 2019](chart.png)
CO$_2$-differentiated taxes on passenger cars in Norway

Red = full exemption for ZEVs*. Green = reduced rate for ZEVs*

1. **Value added tax**, with zero exhaust emission vehicles (ZEVs) exempt

2. One-off **purchase (registration) tax**, consisting of four components

3. **Reregistration tax on second hand sales**, with ZEVs exempt

4. Annual **ownership tax** on cars, collected through the insurance companies

5. **Fuel tax**, consisting of a CO$_2$ component and a road use component

6. Road **toll**, sometimes differentiated by the hour or by the vehicle’s powertrain

7. **Ferry fares**, differentiated between zero emission and conventional cars

8. **Parking fees**, likewise differentiated

9. Income tax on **private use of company cars**, likewise differentiated

*ZEV = zero exhaust emission vehicle = BEV + FCEV
CO₂ differentiated excise taxes and subsidies in Norwegian road transport

10. Annual **ownership tax on heavy freight vehicles**, consisting of two components: weight and Euro-class/powertrain

11. Government **support for fast charging and hydrogen refueling facilities**

12. **Free recharging** for battery electric cars in public parking lots

13. **Scrapping premium** for conventional vans being replaced by a zero emission van (abolished 2020)

14. Direct **subsidies for zero emission light commercial vehicles**

15. Direct **subsidies for zero emission heavy duty vehicles and machinery**
No direct passenger car subsidies in Norway. But second hand import may be subsidized in country of origin.
The CO$_2$ price facing road users

The **extra tax** incurred by businesses and consumers when they choose to own and use a vehicle emitting 1 ton more CO$_2$ than the alternative.

The alternative could be

- Walk
- Bicycle
- BEV
- PHEV or ICEV with lower fuel consumption
- No travel or freight
Fuel tax in 2019: € 0.66 per liter of gasoline, € 0.53 per liter of diesel

- NOK 6.43 = € 0.663 per liter gasoline  
  i.e. NOK 2260 = € 233 per ton CO$_2$ (+ 25 % VAT)
- NOK 5.16 = € 0.532 per liter diesel  
  i.e. NOK 1940 = € 200 per ton CO$_2$ (+ 25 % VAT)

of which the ‘CO$_2$ tax’ was

- NOK 1,18 per liter gasoline, i.e. € 52.37 per ton CO$_2$ (+ VAT)
- NOK 1,35 per liter diesel, i.e. € 52.37 kr per ton CO$_2$ (+ VAT)

The rest is termed ‘road use tax’.

But the labeling is of no consequence. The behavioral response is determined by the total tax.
Norway: one-off registration tax for passenger cars

Diesel: NOK 4690 per ton of CO$_2$

Gasoline: NOK 3650 per ton of CO$_2$
Calculated components of the **price of carbon** facing Norwegian motorists. Euros per ton of CO₂ as of 2019.

![Calculated price of carbon in Norway 2019](chart)

<table>
<thead>
<tr>
<th></th>
<th>Passenger cars</th>
<th>LCVs</th>
<th>Heavy-duty trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel tax</td>
<td>&gt;200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Registration tax: CO₂ component</td>
<td>&gt;400</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Registration tax: weight component</td>
<td>180</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>VAT exemption for ZEVs*</td>
<td>200</td>
<td>≈0</td>
<td>0</td>
</tr>
<tr>
<td>Ownership tax*</td>
<td>140</td>
<td>100</td>
<td>≈0</td>
</tr>
<tr>
<td>Toll*</td>
<td>200</td>
<td>150</td>
<td>&gt;0</td>
</tr>
<tr>
<td>Ferry fares*</td>
<td>10</td>
<td>&gt;0</td>
<td>&gt;0</td>
</tr>
<tr>
<td>Income tax on company car use*</td>
<td>[0, 1000]</td>
<td>≈0</td>
<td>0</td>
</tr>
<tr>
<td>Reregistration tax*</td>
<td>40</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Government subsidies*</td>
<td>≈0</td>
<td>&gt;30</td>
<td>≈0</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>&gt;1370</strong></td>
<td><strong>&gt;640</strong></td>
<td><strong>&gt;200</strong></td>
</tr>
</tbody>
</table>

* Irrelevant for comparison between different ICE vehicles.
The price of carbon corresponds to the marginal social cost of CO$_2$ mitigation i.e. the cost of removing the last ton of CO$_2$ emissions from passenger cars, LCVs or trucks by conversion to all-electric drive.
We have underestimated the carbon price for the following reasons:

1. **Biofuel blend-in**: 16 percent in 2019

2. **The Market Stability Reserve (MSR) of the European Union Emissions Trading System (EU ETS)**: redundant allowances are canceled

3. **EU regulation 2019/631** on CO₂ emission standards for new passenger cars and LCVs: overlapping regulation, acting largely like a cap

4. **Discrepancy between type approval and on-the-road emissions** per km: almost 40 percent in EU in 2019, possibly smaller gap in Norway, on account of lower speed

5. **Life-time vehicle mileage**: possibly less than 260 000 km

6. **Free parking and recharging** for BEVs not included; nor is bus lane access

All of these serve to exaggerate CO₂ emissions and hence to understate the price paid per ton of CO₂.
Can the Norwegian recipe be replicated?

Yes, since it brings revenue into the public treasury. The recipe consists in taxing ICE vehicles, not in subsidizing electric ones. Public finance constraints constitute no counterargument.

On the other hand, certain favorable conditions may not apply outside Norway:

- The electricity supply is based on hydropower and quite cheap and abundant.
- The local grids are strong, allowing for large-scale home charging.
- Most people live in detached or semi-detached houses with a driveway, garage or other designated parking, where a private charging point can be mounted.
- Ample space. Fast charging stations can be set up along major highways.
- Toll roads and ferry crossings are nearly ubiquitous. Through the exemption of BEVs from toll and ferry fares, forceful incentives are created.
- Roads are slow, improving the driving range and making it less of an issue.
- No domestic auto industry lobby that might work against ICE vehicle taxation.
- Governance is strong, with a well-developed system of direct and indirect taxation.
Conclusions regarding carbon price

▪ Our analysis is positive (descriptive), not normative. We reveal the actual price of carbon paid, not the social cost of carbon or the optimal tax.

▪ The price of carbon characterizing the trade-off between ICE and battery electric passenger cars in Norway exceeds €1,370 per ton of CO\textsubscript{2} as of 2019, i.e. about 50 times the price in EU ETS (€26.96 on July 1, 2019).

▪ For light and heavy-duty commercial vehicles, the corresponding prices have been conservatively estimated at €640 and €200 per ton of CO\textsubscript{2}.

▪ In addition, the ‘excess emissions premium’ laid down in EU Regulation 2019/631 implies a price of around €340 per ton of CO\textsubscript{2}, for an automaker not meeting his passenger car target.

▪ The high Norwegian carbon prices result from all taxes and subsidies bearing on road use, fuel consumption or vehicle choice being CO\textsubscript{2}-differentiated.

▪ The most important of these are the one-off vehicle registration tax, the value added tax, the fuel tax, the annual car ownership tax, and the road toll.
Scandinavian comparison

The otherwise similar Scandinavian countries practice starkly different automobile tax regimes.

- The **Danish** system entails *very high and convex tax rates with moderate CO$_2$ differentiation*.

- In **Norway**, tax rates are high, convex and *strongly CO$_2$ differentiated*, with zero emission vehicles totally exempt, even of the value added tax.

- **Sweden** – like France – practices *feebates – CO$_2$ dependent subsidization (bonus)* along with *moderate taxation (malus)*.

- 1.8 million transactions
- > 2000 different model variants per year
- 5 different powertrains
- 35 makes
- 19 nests
- 9 body styles
- no bulkheads – all cars compete in one market
- no data on buyers

Direct and cross price elasticities of demand for gasoline, diesel, hybrid and battery electric cars: the case of Norway

Lasse Fridstrøm* and Vegard Østli
Denmark: steep, convex, value-based tax

Tax typically gives 3-fold increase in price!
Denmark: additional, CO$_2$-based adjustment tax
Sweden: moderate, non-convex, CO\textsubscript{2}-based subsidy/tax

Sweden 2018: net present value of bonus-malus and ordinary ownership tax

- Environmental and diesel adjustments
- CO\textsubscript{2} component of malus
- Ordinary CO\textsubscript{2} based ownership tax
- Base amount
- Bonus
- Total tax - diesel cars
- Total tax - petrol cars

SEK

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

gCO\textsubscript{2}/km
Norway: CO\textsubscript{2}- and weight-based, convex tax
Model simulated rates of emission under varying tax regimes. N0, DK0, S0 are observed values (in 2016 or 2018).
Net fiscal revenue under varying tax regimes

Mill NOK 2016

Net present value of fiscal revenue from new passenger cars

- Registration and ownership tax
- Value added tax

N1, N2, DK1, DK2, S1, S2
Thanks for listening!