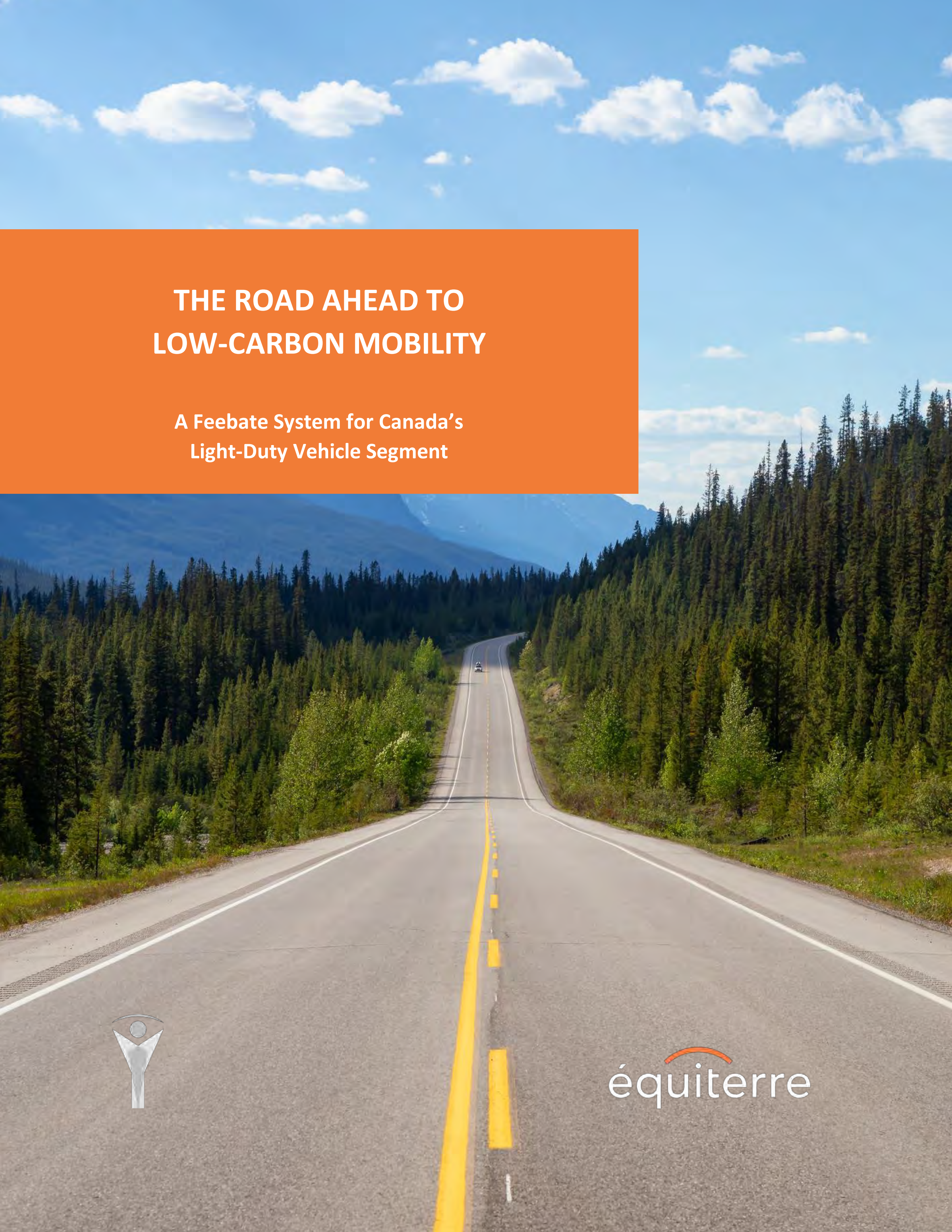


# THE ROAD AHEAD TO LOW-CARBON MOBILITY

## A Feebate System for Canada’s Light-Duty Vehicle Segment

équiterre

**DISCLAIMER AND ACKNOWLEDGEMENT**

This report was commissioned by Équiterre and prepared by Horizon Advisors.

Horizon Advisors and authors of this report assume no responsibility for anyone’s use of the information contained herein.

Research by Amin Asadollahi and Trevor Rous contributed to the drafting of this report.

We would also like to express our sincere appreciation to Andréanne Brazeau of Équiterre and Cedric Smith of the Pembina Institute for their valuable feedback.

# Table of Contents

# Table of Figures



# Terms and Concepts

**BEV** Fully electric vehicle, powered 100% by an electric motor and battery pack; notable for zero tailpipe emissions.

**FCEV** Fuel cell electric vehicle, most commonly equipped with a fuel cell that chemically reacts hydrogen with oxygen to produce 100% of the mechanical energy needed to power an electric motor; have zero tailpipe emissions.

**ICE** Internal combustion engine vehicle, powered using conventional gasoline or diesel fuel.

**PHEV** Plug-in hybrid electric vehicle, powered by small battery packs for short distances (typically 20-50km) before a conventional gasoline (or diesel) engine turns on for longer trips.

**ZEV** Rechargeable battery, multiple battery packs or a chemical (e.g., hydrogen) fuel cell.

# Executive Summary

Équiterre commissioned Horizon Advisors to assess the efficacy of a vehicle feebate system in reducing the tailpipe emissions of Canada's light-duty vehicle (LDV) segment. Horizon reviewed Canada's separately operated bonus-malus programs, which include fees (or a 'malus') on high-emitting vehicles through the federal Green Levy program and rebates (or a 'bonus') for zero-emission vehicles (ZEVs) and plug-in hybrid vehicles (PHEVs) through the government's iZEV program. In addition, we examined bonus-malus systems in leading jurisdictions that have demonstrated improvements in average LDV emissions as well as ZEV and PHEV market uptake.

Canada's Green Levy program is noted to have several underlying weaknesses: its limited application to a small segment of the vehicle market (primarily larger trucks and luxury vehicles), differentiated levels of incentives that support marginal emission improvements by design, and weak price signals. Jurisdictions reviewed in this report have more stringent GHG-based vehicle fees that cover a larger segment of the vehicle market than that of Canada's. When it comes to rebates, although the iZEV program took a step in the right direction in supporting ZEV and PHEV market uptake, incentives offered by Canada are also significantly less than that of leading jurisdictions. As part of their post-pandemic economic stimulus packages, European member states with major automobile manufacturing sectors, in particular, have scaled up their ZEV incentive measures.

This report offers three (3) different approaches for improving Canada's bonus-malus measures through a more cohesive feebate system. It argues that an effective system should ***send appropriate market signals*** through pivot points and slope rates, ***improve the investment environment*** while remaining technology neutral, and ***communicate environmental and economic benefits to consumers***. Feebate design options offered in this report can ultimately support a fully self-funded program, where fees collected on more polluting vehicles are recycled through consumer rebates for the purchase of lower-carbon vehicles. To this end, it is recommended that Canada amend the Green Levy and iZEV programs, bringing them under one administrative body and with common policy objectives that would allow the government to review and adjust both measures in tandem and against a shared set of indicators.

**OPTION A: CONSTANT RATE FEEBATE SYSTEM**

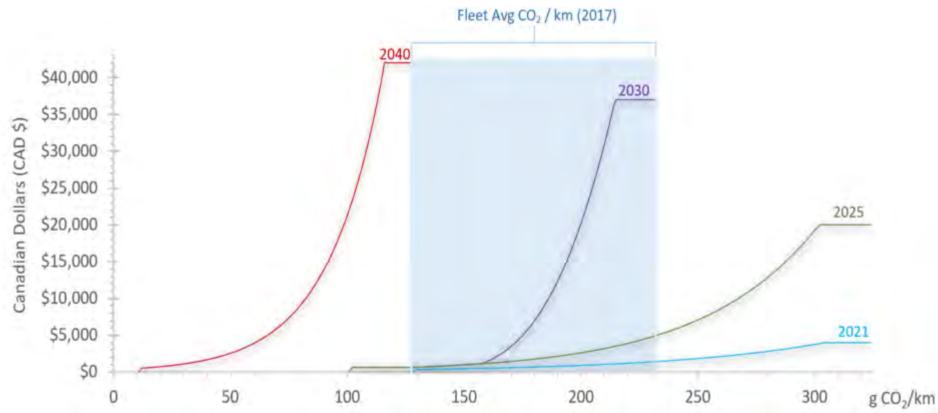
This approach would a set constant fee rate for all ICE vehicles, irrespective of their emissions, and revenues collected would be recycled through rebates for the purchase of ZEVs and PHEVs. The fee rate can be increased annually based on a predetermined schedule that provides sufficient revenues to support a constant rebate rate tied to ZEV targets. For example, an interim ZEV target of 5 per cent in 2022 could be supported by a fee of approximately $500 per ICE vehicle with a ZEV rebate of $10,000. The fee rate would then gradually increase to $1,000 by 2025 while ZEV rebates remain constant at $10,000, which would support a 10 per cent ZEV target. The fee rate would continue to increase until 2040 while rebates remain constant. The government could also exclude lower-cost vehicles from the fee portion, but such approach would result in increased fees on the remaining ICE vehicle segment.

**OPTION B: CIRCULATION FEEBATE SYSTEM**

This approach is comparable to a circulation tax with the difference that the fees are collected by automobile insurance companies rather than governments. The fee portion would consider a vehicle's emission intensity, and it could potentially include distance of travel between work and home as well as annual mileage. It would be applied through insurance policies, and fees collected would then be transferred to the Government of Canada for use at point-of-sale ZEV rebates.

**OPTION C: EMISSION-BASED FEEBATE SYSTEM** (Recommended Option)

This approach offers a system whereby both fees and rebates are determined based on vehicle emissions, and it would allow Canada's bonus-malus measures to align with that of leading jurisdictions over time. Many European jurisdictions have significantly high registration fees and/or circulation taxes that are tied to vehicle $CO_2$ emissions. Although evidence shows that high fees associated with vehicle emissions would dissuade consumers from purchasing more polluting vehicles, this report recommends that an incrementally more stringent fee structure is introduced gradually as the market responds.




The proposed fee structure for 2021 would allow consumers with the choice of selecting lower-emitting vehicles to avoid Green Levy payments altogether. While the stringency of the Green Levy program is improved over time, Canada should immediately scale up its iZEV rebates to match that of leading jurisdictions. It is further suggested that incentives offered directly correlate with the rebate recipient's income. More specifically, key recommendations for an improved iZEV program include:

- 1:3 industry-government cost-shared approach for ZEV and PHEV rebates
- Maximum rebate rate to $15,000, with lower rates for used-vehicle segment
- Correlate the rebate rate directly with the vehicle emissions
- Provide additional rebates when an ICE vehicle is scrapped
- Require retailers to make the rebate value clearly visible to consumers
- Issue ZEV and PHEV rebates by cheque or direct deposit after six (6) and twelve (12) months a buyer has registered the eligible new or used vehicle, respectively.

By improving Canada's bonus-malus measures, under a more stringent and unified system, Canada can send a strong market signal to accelerate the decarbonization of its LDV segment and attract the necessary capital for domestic ZEV manufacturing. However, it is also important to note that there is no silver bullet solution to achieve decarbonization in the LDV segment. In addition to a feebate system, the perfect public policy reform would include an ICE vehicle scrappage incentives directly tied to ZEV purchases, capital incentives for ZEV manufacturers, additional investment in ZEV charging and fueling infrastructure, a national ZEV mandate, and more stringent vehicle GHG regulations.

# 1. Introduction

## 1.1 Policy Context

For its light-duty vehicle (LDV) segment, Canada has set zero-emission vehicle (ZEV) market penetration targets of 10% by 2025, 30% by 2030, and 100% by 2040. However, in the absence of additional government measures, Canada is very likely to miss its ZEV targets and is expected to achieve only 11% ZEV sales in its new LDV segment 2040 (*c.f.*, Navius, 2020). A range of strong market signals will be necessary to drive innovation, increase ZEV availability and affordability, and expand related infrastructure. In so doing, Canada can better prepare its automobile sector for the economy of the future, and fully capitalize on projected ZEV related domestic economic activity of over $150 billion and 1 million jobs by 2040 (ibid). This is an ambitious but feasible undertaking that can be enabled through direct government intervention, policy optimization and program measures while supporting a new vision of mobility.

A transition to a climate compatible and sustainable mobility must tackle the dominant trend in automobile manufacturing that continues to forecast growing demand for fossil fuel powered internal combustion engines (ICEs) over the medium-term. Although, several automobile manufacturers are making significant investments in alternative fueled vehicles (see Table 1), electrification of the LDV segment has primarily focused on plug-in hybrid electric vehicles (PHEVs) while ZEV are largely produced in the luxury vehicle segment. PHEVs with longer emission-free range can have environmental benefits, as majority of Canadian daily commuting does not require long-distance travel. However, not all PHEVs are the same and an analysis of 2020 model year PHEVs offered in Canada demonstrate that emissions of such vehicle vary considerably, from 14 to 180 g $CO_2$/km. The inertia towards low-cost ZEVs and longer range PHEVs is also reinforced by the reluctance of governments to require the automobile sector to align its manufacturing practices with climate objectives and to curb vehicle-reliant mobility (*c.f.,* EASAC, 2019).

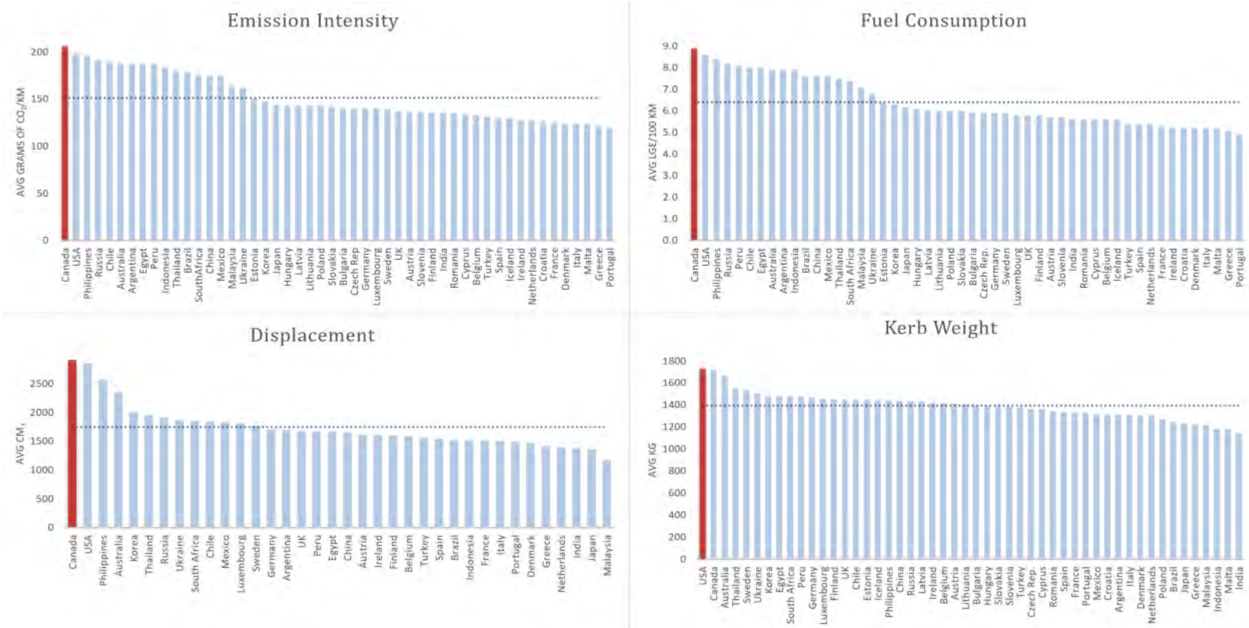
Despite Canada's ZEV targets, rebates, and levies on highest polluting vehicles, the cumulative impact of these measures falls short of what is necessary to drive decarbonization in the sector. In fact, Canada's LDV segment remains one of the highest polluting (see Figure 1) and this is unlikely to change over the medium-term without additional government intervention. According to the International Energy Agency (IEA), Canada's LDV segment has the worst emissions performance (206 grams of $CO_2$ per km) and fuel efficiency (8.9 litres of gasoline equivalent per 100 km) when compared to other major vehicle markets. In addition, Canadian vehicles have the highest power output and displacement as well as the second-highest curb weight compared to vehicles in other major markets. In short, the poor environmental performance of Canada's LDV sector can be attributed in part to the rising sale of larger and less efficient vehicles, with sport utility vehicles (SUVs) and pick-up trucks accounting for over 60 per cent of current market share. There is no silver bullet solution to reverse this trend, and governments need to make difficult decisions, which must include a combination of policy tools and program measures that better align with the country's climate objectives.

*Table 1: An Overview of Alternative Fuels Vehicle Investment by Major Manufacturers*

| Manufacturer | Potential Investment (Approx. CAD) | Potentiel BEV, PHEV, FCEV Options and Availability |
|---|---|---|
| BMW/MINI | $8.7 billion | By 2025: EVs could comprise 15-25% of the group's new vehicle sales; 25 new EV models (incl. 12 new BEVs and 13 new PHEVs) |
| Daimler | $56 billion | By 2022: 10 new EV models. By 2025: EVs comprise 25% of new vehicle sales. By 2030: 130 electrified variations on model line-up |
| Fiat Chrysler | $13.3 billion | By 2022: 4 BEVs and 10 PHEVs in Jeep lineup, 4 BEVs and 8 PHEVs in Maserati lineup, and up to 7 PHEVs in Alfa Romeo lineup |
| Ford | $14.7 billion | By 2022: 16 new BEVs and 24 new hybrids (incl. PHEVs) |
| General Motors | $10.7 billion | By 2023: 20 new EVs and at least one new FCEV likely |
| Honda | $0.7 billion | By 2030: Electrification of two thirds of vehicle portfolio globally, equating to a 15% EV sales share for the company |
| Hyundai/Kia | $26.7 billion | By 2020: 12 new EV models.<br>By 2025: 14 BEVs, 12 hybrids and 2 FCEVs |
| Jaguar/Land Rover | $3 billion | By 2020: Electric versions of all models |
| Mazda | $0.33 billion | By 2020: 1 new EV model<br>By 2030: Only BEVs and hybrids |
| Nissan | $10 billion | By 2021: Electrification of all models in the Infiniti brand.<br>By 2022: 8 new Nissan BEVs on platforms shared with Renault |
| Tesla | $13.3 billion | 2020: Approximately half million EV sales with significant investment in battery production |
| Toyota | $18 billion | Early 2020s: 10 new EV models<br>By 2025: Electric versions of all models (incl. including the Lexus brand)<br>By 2030: 5.5 million EVs worldwide, including 1 million+ ZEVs |
| Volkswagen/Audi/Porsche | $121.5 billion | By 2025: 3 million EVs, 50 BEVs and 30 hybrids models<br>By 2030: 50 million EVs<br>Long-term projection: Electrify all 300 vehicle model types |
| Volvo | $1 billion | By 2020: EV versions of all LDV models<br>By 2021: 5 new BEVs.<br>By 2025: 1 million EVs globally (50% of the group's new vehicle sales) |

Sources: IEA (2019b); Lienert & Chan (2019); Buzzell (2019); CBC (2017); Korosec (2017); Evarts (2019); and public sources.

*Figure 1: Environmental Performance of LDVs in Major Markets (2017)*

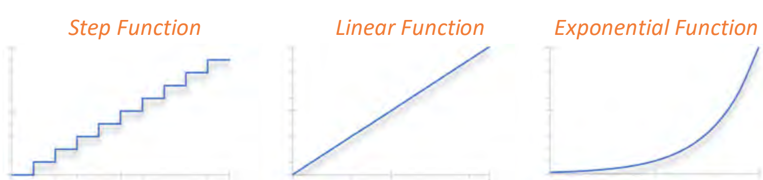



Data Source: IEA, 2019c.
Note: Dotted line represents average value across jurisdictions for which data is available.

## 1.2 An Overview of Bonus-Malus Schemes

Many advanced economies use ZEV subsidies (or a 'bonus') to incentivize ZEV purchases and drive low-carbon infrastructure investment. Others have a Pigouvian tax (or a 'malus') levied against environmental externalities that cause adverse effects (i.e., carbon pollution), with the intent of correcting market failures. Canada has both such measures, but they lack the coherence and stringency required to curb the sector's emissions. This study provides insight on a vehicle feebate model – a cohesive bonus-malus policy based on the environmental performance of vehicles – and offers recommendations on how a well-designed feebate model can be more effective in driving ZEV market penetration than separately operated rebates and tax measures.

In theory, the concept of vehicle feebate programming is quite simple: the consumer either pays a fee based on a vehicle's carbon dioxide ($CO_2$) equivalent emissions (determined by grams of $CO_2$ per kilometer or fuel consumption) or receives a rebate (based on a similar methodology and/or below a certain threshold). The rate of fees and rebates may differ, and it can be set on a step-based function (with a constant fee or rebate indexed to a range of emission levels) or on a continuous-function basis (with varying rates for each additional gram of $CO_2$ emissions) that is either linear or exponential. What makes feebate systems unique is the possibility for governments to design a regime that is self-funded, with fees collected on more polluting vehicles subsidizing those that are more environmentally friendly. The other key benefit of a feebate system is a cohesive policy approach, where both the fees and rebates are guided by, assessed against, and adjusted in tandem to achieve the same policy objectives.

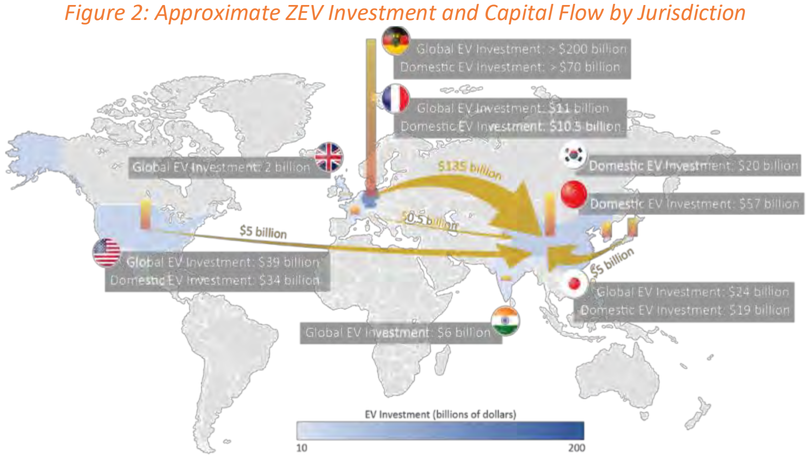


Feebates can be mutually reinforcing with mandatory fuel economy or emission standards because they provide automobile manufacturers with incentives for continuous improvement. Standards are more difficult to administer and are not visible to the consumer while feebates have the advantage of drawing attention directly to the problem of fossil fuel emissions and bring manufacturers, dealers and consumers as participants in the program, albeit with different motivations and roles.

Governments often assume a continuous rate of vehicle efficiency improvement and a steady impact of policies on ZEV market availability, when in practice this usually happens in fits-and-starts. Future $CO_2$ emission reductions in the LDV market are likely to be driven principally by a vehicle supply that may be similar across jurisdictions that demonstrate similar trends. Although feebates appear to primarily provide benefits on the demand side of the equation, they in fact affect the supply side by creating market conditions that are more favourable for a lower-carbon vehicle, supporting R&D efforts, and driving capital investment in ZEV manufacturing.

The range of benefits offered by a well-designed feebate system have been studied extensively (*c.f.,* Mock, 2016; Langer, 2005; Durrmeyer & Samano, 2017; Rivers & Schaufele, 2017; and Greene et al., 2005), and can be generally categorized according to their differential impacts on the government, consumers, the automotive sector, and the environment. An appropriate balance between fees and rebates can benefit ***governments*** by ensuring that the policy remains revenue neutral and self-sustaining while supporting economic activity related to innovation, manufacturing and new vehicle purchasing. ***Consumers***, on the other hand, can benefit from longer-term fuel cost savings, even if higher-cost ZEVs remain out of reach for most car buyers. A feebate system also benefits the ***automotive sector*** over the longer term, by sending appropriate market signals to redirect capital towards investment that is more aligned with climate policies and more competitive in a world that is becoming increasingly carbon constrained. At present, the European Union is leading global ZEV investments while international capital flows are primarily directed to China (see Figure 2) – jurisdictions that have sent strong market signals supporting low-carbon mobility. In part through feebates, Canada can create comparable market conditions for manufacturers to invest in lower-carbon technologies, which are likely to cost less than the reduction in fees or an increase in rebates, along with the expected discounted value of fuel savings. In the final instance, a feebate system introduces ***environmental benefits*** by boosting vehicle fuel efficiency and the demand for ZEVs, while incentivizing the earlier retirement of higher-emitting vehicles.

*Figure 2: Approximate ZEV Investment and Capital Flow by Jurisdiction*




Data Source: Lienert, P. and Chan, C. (2019).
The size of vertical bars represents total EV investment (USD) by jurisdiction.

There is extensive literature on key design aspects of an effective feebate system. The National Roundtable on the Environment and the Economy (NRTEE), for example, summarized the principal variables that can influence feebate design, including metrics used for rates, the form of the feebate function, vehicle classes included, and the point of their application (*c.f.,* M.R. Consultants, 2005). The International Council on Clean Transportation (ICCT), on the other hand, has undertaken extensive research on feebate systems, with key themes that include the need for strong incentives, effective communication of benefits, the use of progressive benchmarks, importance of technology neutrality, and design adjustments based on revenue streams (*c.f.,* German & Meszler, 2010).

At a high level, the implementation of a well-designed feebate system should start with a clearly articulated policy objective, followed by an assessment of how programming can have an impact on the demand side as well as on the supply side of the equation. To this end, Canada's policy objectives are clearly outlined through its ZEV targets, as well as its 2030 and mid-century climate objectives. Key among the design elements of a feebate system are determinations related to pivot points and rates, the need to create an investment environment that supports the transition to lower-carbon mobility, and the communication of its benefits to the broader public.

***Send appropriate market signals*** through pivot points and slope rates that offer incentives to improve the environmental performance of vehicles across the range of model offerings. In this regard, continuous functions are more effective than step-based approaches, which primarily incentivize improvements closer to each price point rather than across the range of vehicle emissions. In addition, the rebate portion should be set at the highest appropriate level at program inception and decrease over time while the rate and slope of the fee portion should accordingly increase as the vehicle market responds. It is important to note that revenues from the fee portion will decrease overtime as the efficiency of a jurisdiction's fleet improves – a sign of the program's success.

***Improve the investment environment*** through a feebate program that survives governments and remains technology neutral. Technology neutrality is a strength of feebates and can offer the sector the ability to make appropriate business decisions with comparably equal incentives for a range of advanced technologies. It also allows manufacturers to innovate using the most cost-effective approach and without governments determining technology outcomes. In order to improve investment certainty, governments should also avoid major revisions – particularly with changes in government – and rather focus on adjustments to pivot points based on program outcomes.

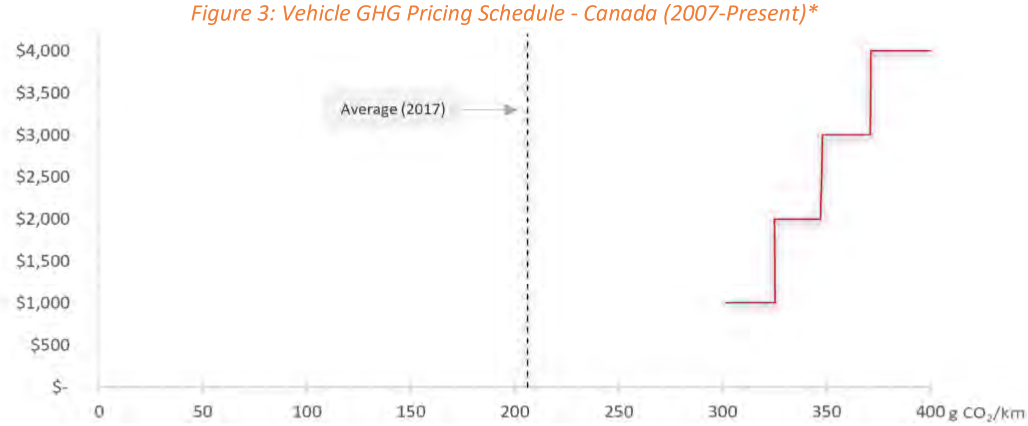
***Communicate benefits to consumers*** including environmental impacts and economic advantages of lower-carbon vehicle ownership, such as longer-term fuel cost saving. In this regard, the Government of Canada's EnerGuide for Vehicles labelling program (with information on fuel consumption, fuel economy, annual fuel costs, vehicle class range, and $CO_2$ and smog rating) provides a good model to expand on. This is particularly important in the Canadian context where federal and provincial governments did an overall poor job in communicating the benefits of the carbon pricing regime. Feebates could face opposition, particularly at their initial point of implementation if their overall benefits are inadequately communicated and the fee portion of the policy is perceived simply as an additional tax.


## 2. A Comparative Analysis of Bonus-Malus Programs

Although a summary of Canadian subnational bonus-malus schemes is provided below, the principal focus of this report is federal measures that can support decarbonization efforts in Canada's LDV segment. The concept of feebate is certainly not foreign in the Canadian public policy sphere. In late 1990s, federal departments explored the potential of vehicle feebate programming, most notably with a study commissioned by Natural Resources Canada (NRCan, 1999). In 2005, the Government of Canada announced its intention to further investigate how feebates might complement an agreement reached with automakers on $CO_2$ emission reductions. The National Roundtable on the Environment and the Economy (NRTEE) was tasked with examining the possibility of using feebates under a set of guidelines that included environmental objectives and revenue neutrality (M.R. Consultants, 2005; Banerjee, 2007).

Canada's initial foray into emissions-based taxation and subsidy programming followed in 2007 with the introduction of the federal Vehicle Efficiency Incentive (VEI). The initiative included twin programs that were administered separately – Transport Canada processing the ecoAuto rebate cheques for qualified applicants and Department of Finance overseeing the Green Levy by imposing the excise tax at the point of purchase. The fee portion, which continues to date, uses a step-function starting with $1,000 of fees applied to passenger vehicles (cars, minivans, SUVs) with fuel consumption ratings of 13L/100 km, increasing by $1,000 for every 1L/100 km to a maximum of $4,000 (see Figure 3). In comparison, vehicle malus fees in France and Italy are applied starting at 138g $CO_2$/km and 161g $CO_2$/km, respectively (see Figure 4). Moreover, while all new vehicles sold in Canada since 2015 are labelled using a five-cycle test for determining vehicle emissions (incorporating a wider range of real-world driving patterns and environmental conditions), the Green Levy is assessed on a comparatively less stringent two-cycle test that is performed at ambient temperatures.[1]

*Figure 3: Vehicle GHG Pricing Schedule - Canada (2007-Present)**

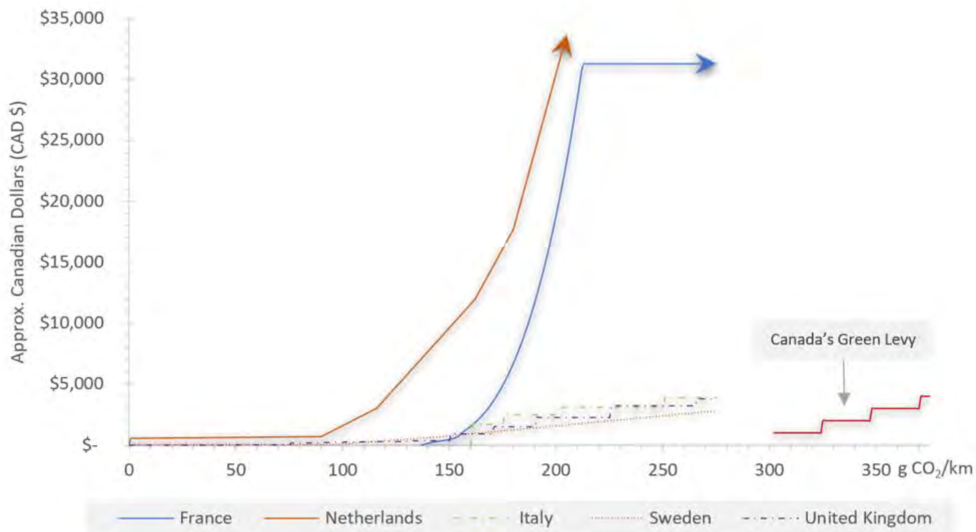



*Converted from dollars per litre to approximate g $CO_2$/km

[1] Figures provided in this report use data from multiple sources that use different emissions testing methods. Although an exact side-by-side comparison is not possible, taken together the figures provide a conservative comparative representation.

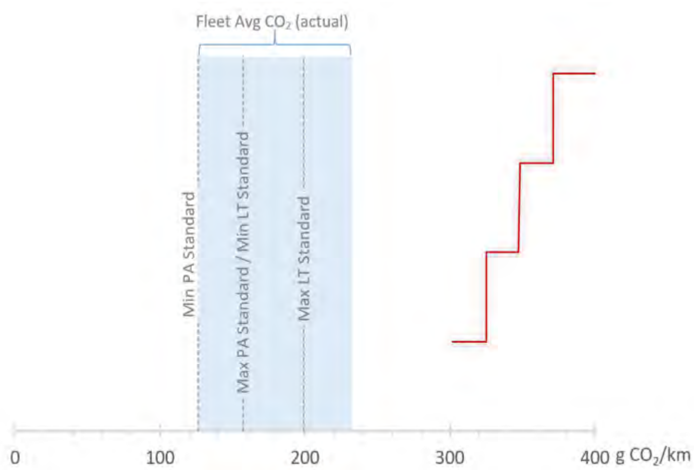
Other jurisdictions apply the fee portion at the point of purchase or through annual circulation taxes, covering the broadest possible range of vehicles with some that start from the first gram of a vehicle's average emission. When converted to its corresponding emissions, the Canadian Green Levy is applied starting at approximately 302g $CO_2$/km. In addition, the price stringency of Canada's Green Levy is weak – it amounts to about a third to a quarter of those imposed in other leading jurisdictions, more than $30,000 less than that of the high end of capped fees in France, and a fraction of that of the Netherlands.

*Figure 4: Comparison of Vehicle GHG Pricing Schedules*




Furthermore, the Canadian fee scheme is set above the range of fleet average $CO_2$ emissions and regulatory targets. Figure 5 provides the range of fleet average standards for passenger automobiles (PA) and light trucks (LT) that manufacturers must meet. Accordingly, Canada's Green Levy covers a small percentage of vehicles, mainly affecting the luxury segment and larger, more expensive SUVs.

*Figure 5: Fleet Average CO2 Standard versus Green Levy (2017)*

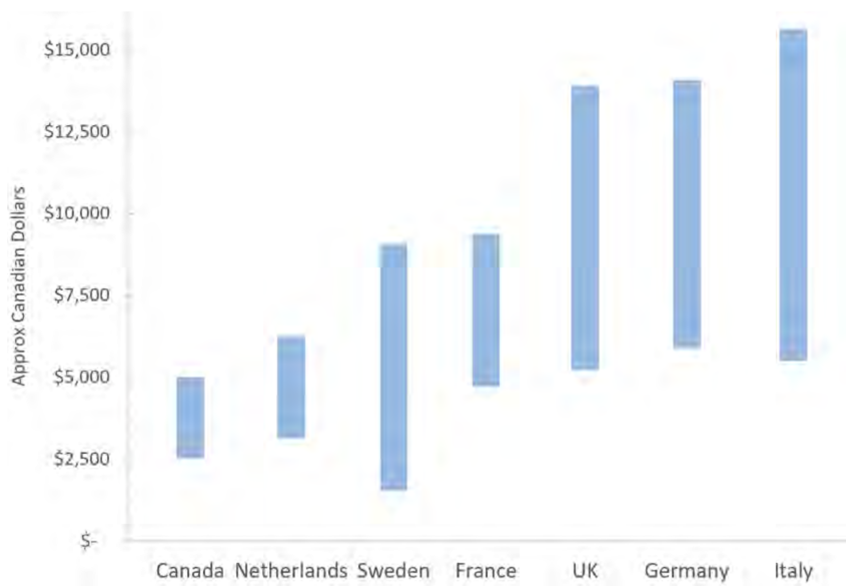



Data source: ECCC, 2018.

Under the now-canceled ecoAuto rebate, passenger cars with fuel consumption ratings better than 6.5L/100 km, and light-duty trucks better than 8.3L/100 km, were eligible for an initial rebate up to $1,000 plus an additional $500 for every additional 0.5L/100 km below the specified benchmark. The step-function schedule offered little incentive to vehicles in the broad middle range of each step, while disqualifying those that were just above a threshold. For example, the Honda Fit and the Honda Civic both missed the 6.5L/100 km rebate by mere fractions, disqualifying them from the $1000 rebate. At the same time, the exclusion of pick-ups and large vans from the incentive portion also drove consumer demand towards this segment.

In 2019, the Government of Canada introduced the iZEV program, offering rebates of up to $5,000 for ZEVs and $2,500 for PHEVs with a base model retail price of $45,000 or less. iZEV also allows for business tax expense write-offs in the year a procured ZEV is put into use. Although it represents a significant improvement on the previous program, Canadian ZEV rebates are significantly less than those on offer in most other jurisdictions reviewed in this study (see Figure 6).[2] One of the highest rebates is that of the German federal government, at up to approximately $14,000, which were increased in 2020 as part of Germany's post-pandemic economic recovery measures designed to accelerate the market availability and uptake of lower-cost ZEVs in that country. France and Italy provide rebates of up to approximately $9,400, with the latter raising such incentives to approximately $15,600 if an ICE is scrapped in the process of acquiring a ZEV. Through vehicle scrappage measures, governments purchase and then recycle older, less efficient, and more polluting vehicles. The tying of ICE vehicle scrappage incentives directly with the purchase of ZEVs, allows governments to achieve multiple policy objectives simultaneously: reducing LDV emissions by taking ICE vehicles off the market and stimulating economic activity in the automobile sector by creating demand for ZEVs. Also noteworthy is Sweden's incentive program that covers a larger segment of lower-emitting vehicles, with rebates tied directly to emissions of up to 70g $CO_2$/km.

*Figure 6: Range of ZEV and PHEV Rebates in Select Jurisdictions*

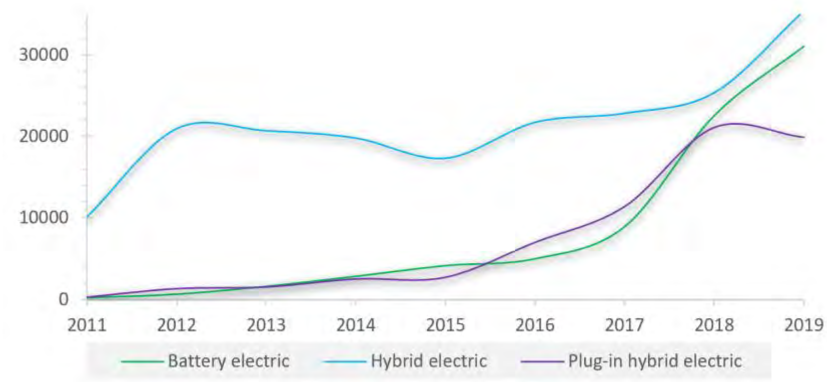



Not only is the stringency of Canada's fee and rebates program weaker than other leading jurisdictions, but the overwhelming majority of new vehicle purchases fall outside of eligibility for both the Green Levy

[2] Currency conversions are rounded to Canadian dollars using the following exchange rates: US dollar (USD) 1.318, Euro (EUR) 1.564, UK pound sterling (GBP) 1.737, Danish krone (DKK) 0.210, Swedish Krona (SEK) 0.151.

and the iZEV programs. Perhaps it is therefore not surprising that these programs have not had a significant impact on the transitioning of Canada's vehicle fleet to lower-emitting vehicles, which remain limited to about 5 per cent or approximately 87,000 of total vehicles registered in 2019 (see Figure 7).

*Figure 7: New Alternative Fuel Vehicles Registered - Canada*




Data source: Statistics Canada

At the provincial level, Ontario's attempt at a feebate system in the 1990s provides a good case study of a subnational jurisdiction with a strong vehicle manufacturing sector. The provincial 'Tax and Credit for Fuel Conservation' (TFC) program applied a fee on all new car purchases that had a highway fuel consumption rating exceeding 9.5L/100 km, which converts to about 220g $CO_2$/km. The initial fee was $600 for passenger cars consuming between 9.5-12.0L/100 km increasing to $3500 for cars with ratings greater than 18.0L/100 km. One year later, tax rates were doubled and extended to cover cars with a wider range of fuel economy ratings, with fees on the most fuel-inefficient vehicles equalling $7000. In 1991, the scope of the program was further expanded to include a larger number of vehicles (notably SUVs), while passenger vans and pick-up trucks remained exempt. The program also offered $100 rebates for the best performing passenger vehicles with fuel consumption of less than 6L/100 km combined with tax exemptions. The tax rate on the bottom two (2) brackets was also reduced relative to the 1990 levels – the fee on cars with fuel efficiency ratings of 8.0-8.9L/100 km were dropped from $200 to $75, while for the 9.0-9.4L/100 km bracket it decreased from $700 to $250. The program was terminated in 2010.

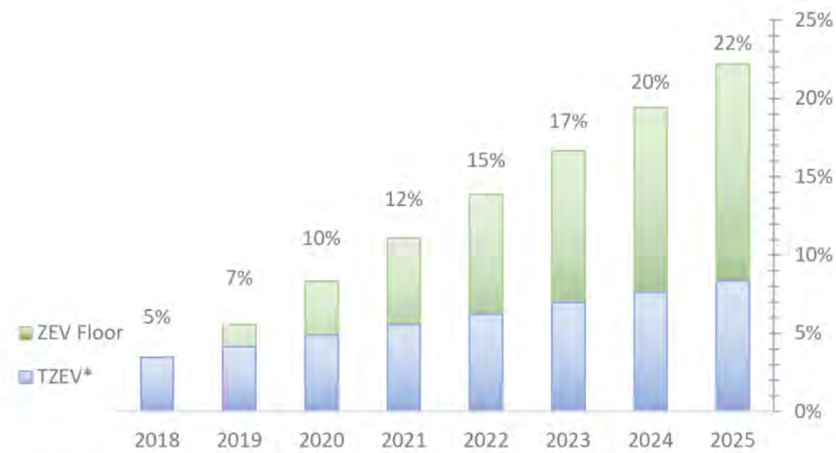
Critics charge that in practice the program worked much more like a gas-guzzler tax than a true feebate (*c.f.,* Langer, 2005; Antweiler & Gulati, 2013). Some of the shortcomings of the TFC program include: (1) poor outreach and communication of fees (which dealers passed on to consumers); (2) the fact that the vast majority of new vehicles sold across the province fell into the range of the rather meagre $75-100 ecoAuto rebate; (3) the low value of the rebate did not impact purchasing decisions; and (4) the exclusion of many high-emitting vehicles. The TFC program improved the lifetime vehicle $CO_2$ emissions by only about 0.6 million tonnes per vehicle, and Rivers and Schaufele (2017) suggest that a true revenue-neutral policy would have reduced emissions by 1.3 million tons compared to a no-feebate scenario. The province had significant room to increase incentives offered, as "the combination of fees and rebates was revenue positive in every year that the program existed" (Rivers & Schaufele, 2017: 9). Revenues generated from the program ranged between $20 to 40 million annually, while credits cost the province between $1.9 million to $6.6 million. In 2018, the province introduced significantly higher incentives of up to $14,000 under its Electric and Hydrogen Vehicle Incentive Program, which was soon after cancelled by the new government.

Only two (2) Canadian provinces currently offer rebates at the subnational level. British Columbia's Go Electric Vehicle Incentive Program offers rebates of $3,000 for the purchase or lease of ZEVs and longer-range PHEVs, along with $1,500 for shorter-range PHEVs at the point-of-sale. Quebec offers rebates of $8,000 for the purchase or lease of new ZEVs and up to $4,000 for used electric vehicles, while PHEVs rebates are determined based on battery capacity.

## 2.1 California

The State of California unsuccessful attempt at a feebate program can be traced to a 2008 bill titled the "Clean Car Discount for California Families", sponsored by the Union of Concerned Scientists. The bill proposed a surcharge of USD$2,500 (CAD$3,250) for high-emitting vehicles and that the resulting revenues to be reinvested through rebates for the purchase of lower-emitting passenger vehicles, trucks, and SUVs. Moreover, the feebate system was envisioned as a complementary measure to California's vehicle GHG regulations and its ZEV mandates that date back to 1998. The State's latest ZEV Action Plan requires manufacturers to fulfil percentage-based ZEV vehicle credit requirements (see Figure 8)[3] and manufacturers that fail to meet the credit requirements are then penalized in the amount of USD$5,000 (CAD$6,500) per ZEV credit deficit.

*Figure 8: ZEV Credit Requirement - California*




* TZEV are qualified vehicles (mainly PHEVs) that meet California's Transitional Zero Emission Vehicle requirements.
Data Source: California LEV Regulations with amendments (October 2019)

Despite having the most stringent US vehicle regulatory requirements for over two (2) decades, California has recognized that ZEV mandates need to be complemented with other incentive-based measures. The State's Clean Vehicle Rebate Program offers vehicle purchase and lease rebates of USD$4,500 (CAD$5,850) for FCEVs, USD$2,000 (CAD$2,600) for BEVs and USD$1,000 (CAD$1,300) for PHEVs. A unique feature of the program is its income cap for rebate eligibility, set at USD$150,000 (CAD$195,000) per year for single filers. In addition, lower-income individuals are eligible for even higher incentives of up to USD$7,000 (CAD$9,100) for FCEVs, USD$4,500 (CAD$5,850) for BEVs, and USD$3,500 (CAD$4,550) for PHEVs. Income considerations can play an important role in broadening ZEV uptake by targeting lower-income individuals (*c.f.,* PIEEE-UC-Davis, 2019).

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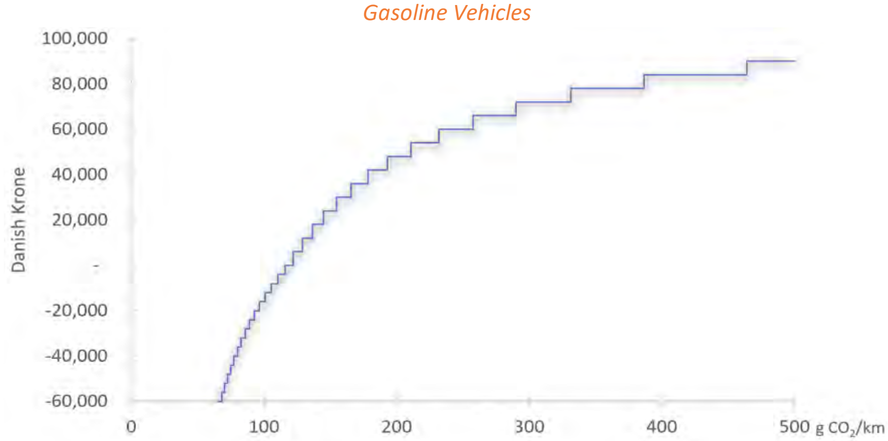
[3] Credits are determined based on the vehicle's range, which varies from 1 to 4 credits for BEVs and FCEVs with a range of 50 to 350 miles (80 to 563 kms) and 0.6 to 1.3 credits for PHEVs with a range of 10 to 80 miles (16- to 128 kms) of electric range.

California is considering an increase to BEV rebates to USD$7,500 (CAD$9,750) under Assembly Bill 1046. Proposed amendments to the policy would prohibit the State from using a fee portion to fund the program;[4] an addition which has been argued to have been included following an inquiry by automobile industry associations (Dawid, 2019). The bill is currently in committee and it is not clear how the state will fund the potentially high-cost program without some type of levy. The University of California's Institute of Transportation Studies has suggested that fees and rebates should target vehicles with fuel consumption that fall within the top and bottom 15 per cent, and that the 5th and 95th percentile of vehicles be assessed an identical fee and rebate of USD$2,500 ($CAD3,250), while the 15th and 85th percentile should be assessed a fee and rebate of USD$500 (CAD$650) (Jenn, 2019).

## 2.2 Denmark

Denmark applies a significantly high vehicle registration fee, which is further adjusted based on a vehicle's fuel consumption. The base registration tax is 85 per cent of a vehicle's taxable value (including value added tax) up to DKK185,100 Danish kroner (CAD$39,000) and 150 per cent above this threshold. BEVs and PHEVs registered in 2021 will be charged 65 per cent of the noted registration tax, increasing to 90 per cent in 2022 and 100 per cent in 2023. Denmark also uses a vehicle's fuel consumption to determine an additional registration tax of DKK6,000 (CAD$1,260) per km below 20 km/L for gasoline vehicles and 22 km/l for diesel vehicles. The base tax of vehicles with fuel efficiency that is above these thresholds is reduced to DKK4,000 (CAD$840) per kilometer. When converted to grams $CO_2$/km, the slope of Denmark's feebate scheme becomes increasingly flat with rising emissions (see Figure 9), and this is unlikely to drive improvements to very high-emitting vehicles.

*Figure 9: Registration Tax Adjustments - Denmark (2020)*
*Gasoline Vehicles*




Data source: *Skatteforvaltningen* 2020. Converted from km/L to g $CO_2$/km.
Negative values represent a reduction in registration tax.

A unique administrative aspect of Denmark's approach is the application of all fees and deductions at the point of sale, built into the final price shown at the dealership, which allows consumers to compare vehicles more easily. Although fees and rebates may be less transparent to consumers as a result, the efficacy of Denmark's approach is observable through improvements to country's average fuel

[4] More specifically, it notes that "[t]he funding plan shall not include a new fee structure on vehicles that varies based on the greenhouse gas emissions of the operation of that vehicle" and that the bill "[…] does not provide the state board with new authority to assess a penalty, surcharge, or similar cost on a vehicle or a vehicle manufacturer".

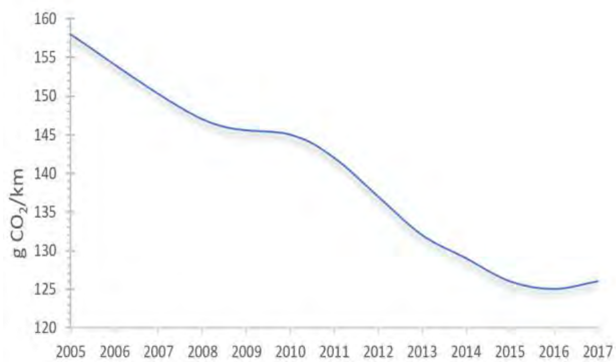
consumption (*c.f.,* Jenn, 2019), which remains one of the lowest among OECD countries at 5.2 L/100 km (as compared to that of Canada at 8.9 L/100 km).

## 2.3 France

France's vehicle feebate system was first introduced in 2008, with the objectives of achieving revenue neutrality and reducing the average vehicle emissions to 130g $CO_2$/km 2020. Initially, rebates provided ranged from €200 to €1,000 (CAD$300 to $1,600) for the purchase of vehicles with emissions less than 130g $CO_2$/km, and fees of €200 to €2,600 (CAD$300 to $4,100) were applied to vehicles emitting more than 160g $CO_2$/km, administered at the point of sale (Durrmeyer & Samano, 2017: 5).

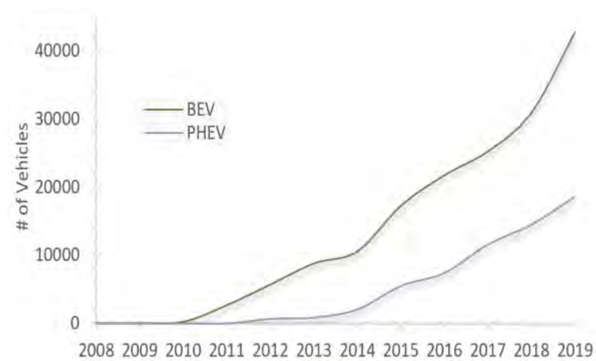
The prevailing assessment is that France's feebate system is successful; it has exceeded its targets ahead of schedule, with a reduction in average $CO_2$ emissions from its LDV fleet to 126g $CO_2$/km in 2017 (see Figure 10), and an increase in the market share of new BEVs and PHEVs registered to about 10 per cent in 2019 (see Figure 11). Although these improvements cannot be attributed directly to the design of the bonus-malus system (i.e., the strengthening of the EU's $CO_2$ standards has likely affected France's fleet composition), comparison with outcomes in other EU member states is nevertheless instructive. For example, new vehicles in France achieved a reduction of 8g $CO_2$/km in 2012 as juxtaposed to the emission reductions of 1.7g $CO_2$/km and 0.6g $CO_2$/km achieved in Germany and Sweden, respectively, in the same calendar years (Klier and Linn, 2012).

*Figure 10: Average $CO_2$ Emissions per Kilometer - France*




Data source: IEA, 2019c.

*Figure 11: New Alternative Fuel Vehicles Registered - France*



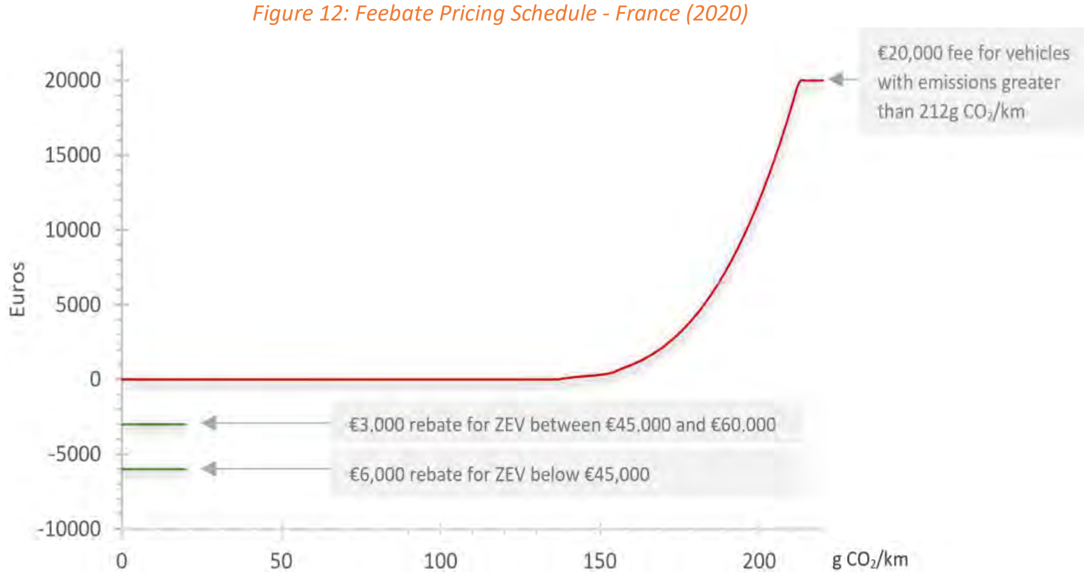

Data source: European Alternative Fuels Observatory, 2020.

Key among the shortfalls of the French feebate system was its step-based function for rewards and fees, which offered different levels of incentives for different vehicle performances, with highest rewards offered for vehicles that are effectively closer to a step (Schroten et al., 2014: 43). This motivated manufacturers to make small improvements to vehicles that were the closest to the next level of fees.

Critics of how the program operated in its infancy argued that if the tax rate line were made continuous or constant (for each g $CO_2$/km), then marginal compliance costs would be equalized across all car models. In theory, this would drive efficiency innovation in the auto industry. However, Yang (2018b) observes that "… [a] continuous feebate function is more effective because it provides an uninterrupted incentive to improve vehicle efficiency". Yang further notes that such an approach simplifies the usual forms of supply-side analysis associated with vehicle fleet trends and budget forecasting, "… as it is more straightforward to predict the market reaction based on elasticity of the purchase cost of vehicles" (*ibid*).

France gradually narrowed the band between each step, and in 2017, it changed the fee portion from a step-based to a continuous function. As of 2020, the fee portion has been doubled and is applied starting at 138g $CO_2$ per kilometer (see Figure 12). The change to a continuous function is perhaps the most important innovation in vehicle feebate programming anywhere, as the high number of gram $CO_2$/km gradations has enabled more complete coverage of the new automobile market across the country while addressing the above-noted unintended impacts of the step-function system.

*Figure 12: Feebate Pricing Schedule - France (2020)*




Data source: *Gouvernement de la République française*, 2019; Wappelhorst, 2020
Negative values represent rebates.

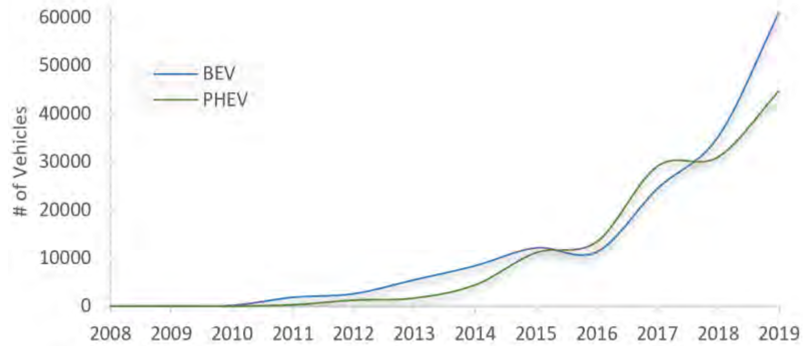
For the incentive portion targeting vehicles with emissions of less than 20g $CO_2$/km, France provides rebates of up to EUR €6,000 if the purchase price is less than €45,000, and rebates of up to €3,000 if the purchase price is between EUR €45,000 and €60,000 (up to a maximum 27 per cent of the acquisition cost). As of 2018, PHEVs are no longer eligible for rebates under the program.

## 2.4 Germany

Germany has two (2) separate motor vehicle taxes (*Kraftfahrzeugsteuergesetz*) that consider vehicle emissions. In place since 2002 and amended in 2017, these fees are marginal and are unlikely to have had an impact on consumer purchasing behaviour. As of 2014, an annual fee based on its engine capacity (set at €2 and €9.50 per 100 $cm^3$ for gasoline and diesel ICEs, respectively) is applied to vehicles with emissions above 95g $CO_2$/km as well as an annual fee based on the vehicle's emission intensity (set at €2 per g $CO_2$/km). ZEVs are tax exempt for a period of ten (10) years.

Germany's rebate scheme for lower-carbon vehicles, on the other hand, is particularly noteworthy and it is likely to have contributed to the rapid uptake of ZEVs in that country (see Figure 13). As of June 2020, Germany increased its rebates to €9,000 (CAD$14,000) for BEVs and FCEVs and EUR €6,750 (CAD$10,500) for PHEVs for vehicles with retail value of up to €40,000 (CAD$62,600). The rebate is reduced to €8,000 (CAD$12,500) for BEVs and FCEVs and to EUR €5,625 (CAD$8,800) for PHEVs with a retail value between €40,000 and EUR €65,000 (CAD$101,700). To be eligible, PHEVs must have an electrical range of more than 40 km, which rises to 60 km in 2023 and to 80 km in 2025. Used BEVs are also eligible for incentives of €5,000 (CAD$7,800), while used PHEVs receive €3,750 (CAD$5,800) in rebates.

*Figure 13: New Alternative Fuel Vehicles Registered - Germany*

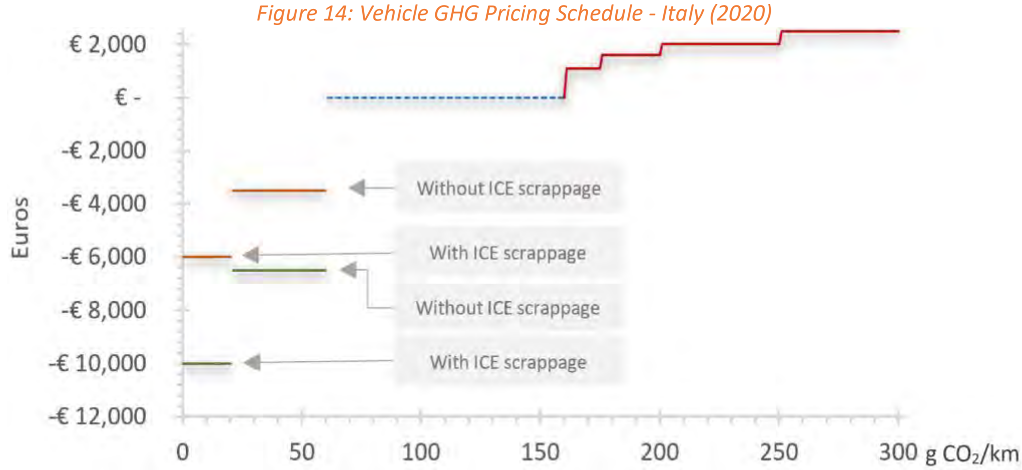



Data source: European Alternative Fuels Observatory, 2020.

## 2.5 Italy

In 2019, Italy introduced a bonus-malus scheme with step-based fees applied to vehicles emitting more than 160g $CO_2$/km, and rebates awarded for vehicles with a gross list price of €61,000 (CAD$95,400) that emit less than 20g $CO_2$/km (see Figure 14). Rebate recipients are also eligible for higher incentives if they scrap a vehicle with European emission standards of 0 to 4. The incentive was initially set at €4,000 (CAD$6,300) for vehicles with emissions of up to 20g $CO_2$/km, and €6,000 (CAD$9,400) with scrappage benefits. For vehicles with emissions of 21 to 60g $CO_2$/km, the rebate was set at €1,500 (CAD$2,300), and €2,500 (CAD$3,900) with scrappage benefits. In order to spur economic recovery in response to the COVID-19 pandemic, Italy temporarily increased its rebates to €6,000 (CAD$9,400) and to €10,000 (CAD$15,600) with scrappage benefits for vehicles with emissions below 20g $CO_2$/km, and to €3,500 (CAD$5,500) and €6,500 (CAD$10,200) with scrappage benefits for vehicles with emissions between 21g to 60g $CO_2$/km. Because the policy is relatively new, there are no significant observable trends attributable to Italy's bonus-malus scheme. In fact, the lack of strong regulations until the introduction of the bonus-malus scheme can be noted as a key factor behind the generally low market penetration of ZEVs in that country (approximately 17,000 BEVs and PHEVs in 2019).

*Figure 14: Vehicle GHG Pricing Schedule - Italy (2020)*



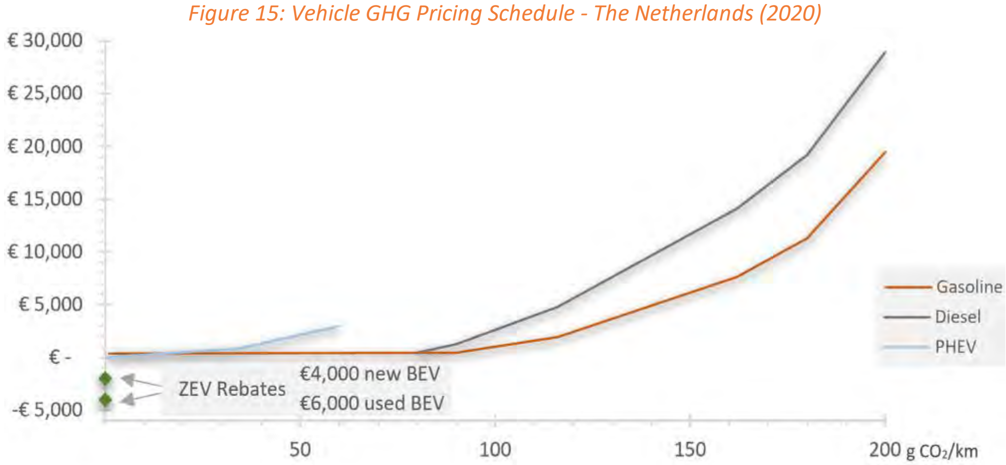

Data source: European Alternative Fuels Observatory, 2020; IEA Policies Database, 2020.

Negative values represent rebates.

## 2.6 The Netherlands

The Netherlands has some of the most stringent fees of any bonus-malus scheme. In 2008, it amended its vehicle taxation policy for passenger vehicles and motorcycles (*Belasting Personenauto's Motorrijwielen*) to take account of $CO_2$ emissions. The policy initially targeted higher-emitting gasoline and diesel vehicles, with emissions above 233 and 193g $CO_2$/km, respectively. In subsequent amendments the fee was expanded to cover all ICE vehicles and PHEVs, and all vehicles have been made subject to a higher pricing regime. For ICE vehicles, the fee is determined based on a continuous function that increases exponentially at emission levels of 90g, 116g, 162g and 180g $CO_2$/km, plus a surcharge for diesel vehicles (see Figure 15). In addition, the policy demonstrates a partial bias against PHEVs with emissions above 16g $CO_2$/km.

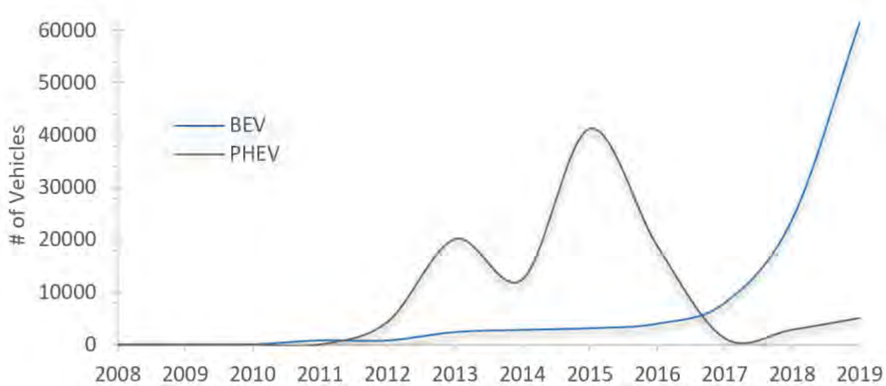
*Figure 15: Vehicle GHG Pricing Schedule - The Netherlands (2020)*




Data source: *Belastingdienst*, 2020; European Alternative Fuels Observatory, 2020.
Negative values represent rebates.

The Netherlands has an ambitious goal of phasing out conventional ICE vehicles by 2035. It offers rebates of €4,000 (CAD$6,300) for new and €2,000 (CAD$3,100) for used BEVs with retail price of €12,000 (CAD$19,000) to €45,000 (CAD$70,000) and a range of more than 120 km. FCEVs are not covered under the rebate program. The combination of high fees against ICE vehicles and rebate measures have supported the rapid rise of ZEVs, with consumers demonstrating a preference for BEVs over PHEVs (see Figure 16).

*Figure 16: New Alternative Fuel Vehicles Registered - The Netherlands*

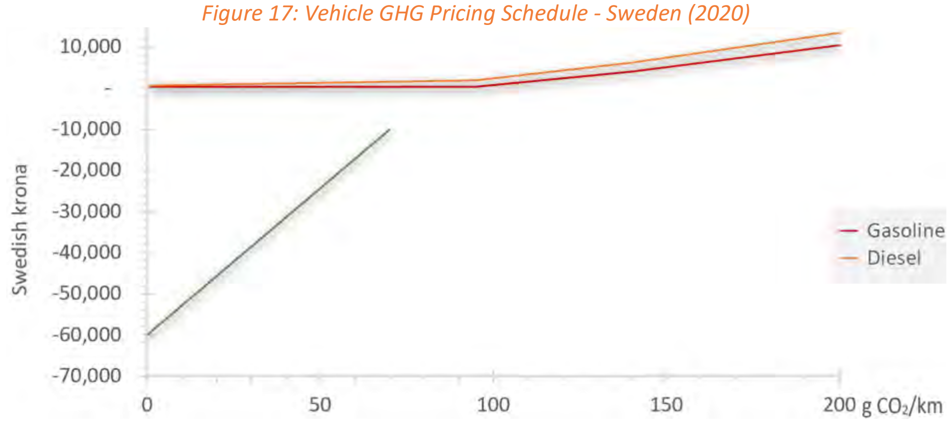



Data source: European Alternative Fuels Observatory, 2020.

## 2.7 Sweden

In 2018, Sweden's Climate Policy Framework (*Ett klimatpolitiskt ramverk för Sverige*) came into force and set a commitment of net-zero GHG emissions by 2045 and a 70 per cent emissions reductions from domestic transportation by 2030 (excluding domestic aviation). In the same year, the Swedish government implemented a vehicle bonus-malus scheme with a continuous function based on incentives that are exponentially more favourable to lower-emitting vehicles (see Figure 17). Rebates are processed by the Swedish Transport Agency and directly deposited into the purchaser's bank account after six (6) months of vehicle ownership. As of 2020, Sweden provides rebates of up to SEK60,000 Swedish kronor (CAD$9,100) for vehicles emitting up to 70g $CO_2$/km, capped at 25 per cent of the vehicle's retail value. ZEVs receive the full rebate, while higher emitters see the bonus reduced by SEK714 ($110) for every gram of $CO_2$/km. For three (3) years following registration, Sweden also applies a fee based on a vehicle's emissions that increases significantly at 140g $CO_2$/km. The fee portion includes a basic annual fee of SEK360 (CAD$54) and an additional fee of SEK82 (CAD$12) per gram of $CO_2$ for vehicles emitting between 95g and 140g $CO_2$/km and SEK107 (CAD$16) per gram for vehicles above 140g $CO_2$/km. Diesel vehicles pay an additional annual surcharge of SEK250 (CAD$38) and a fuel surcharge (vehicle $CO_2$/km emissions multiplied by 13.52).

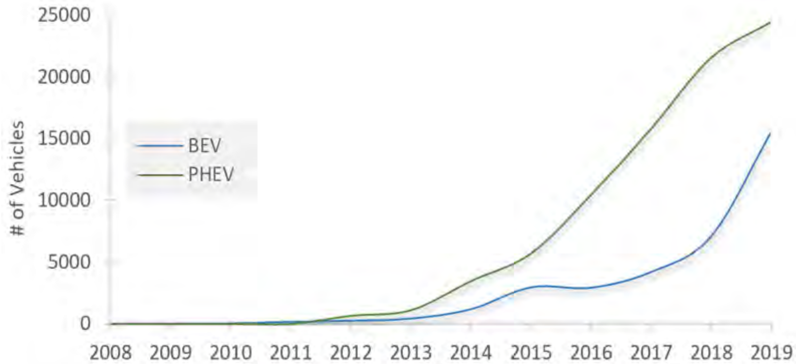
*Figure 17: Vehicle GHG Pricing Schedule - Sweden (2020)*




Data source: *Transportstyrelsen*, 2020.
Negative values represent rebates.

Several unique features of the Swedish feebate scheme have proven instructive for other countries. The government deferred paying out its ZEV bonus until six (6) months after car registration, to counter any temptation buyers might have to collect the bonus and then immediately resell their vehicles. The malus portion is spread over a period of three (3) months, and while reducing the initial cost burden, it also acts as a disincentive for ICE purchases as the higher cost is extended over a period. Moreover, there is evidence that the bonus-malus scheme may have shifted the composition of Sweden's passenger vehicle fleet towards a significant rise in BEVs and PHEVs registrations since the policy came into force – from just above 5 per cent at the end of 2017 to over 25 per cent by the end of 2019 (see Figure 18).

Figure 18: New Alternative Fuel Vehicles Registered - Sweden



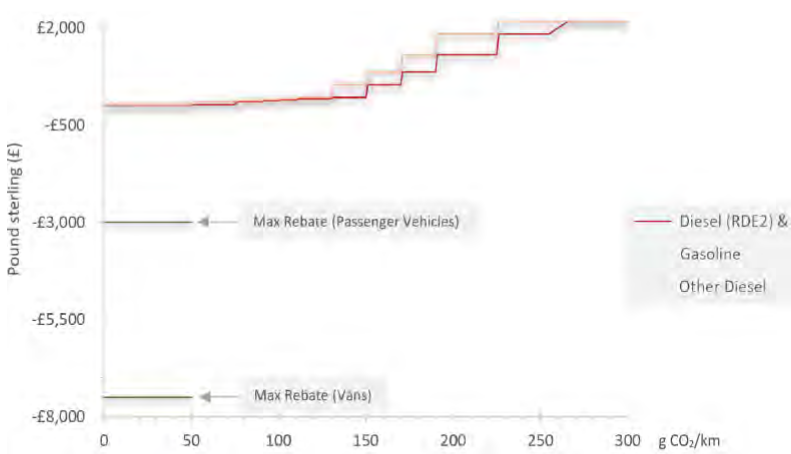

Data source: European Alternative Fuels Observatory, 2020.

## 2.8 United Kingdom

The United Kingdom (UK) fee component is applied through a circulation tax, which was initially based on engine size (indirectly related to $CO_2$ emissions) and modified in 2001 to consider the vehicle's $CO_2$ emissions the first time a vehicle is registered. Despite being applied as a circulation tax, the significantly higher fee for the first year of a vehicle's registration is comparable to a fee applied at the point of purchase, and ZEVs are exempt from the circulation tax altogether.

The policy initially introduced four (4) $CO_2$ categories; it was modified in 2006 to include more differentiated tax brackets for different vehicle emission profiles, and it now uses a step-based function (see Figure 19). ICE vehicles with a retail value above £40,000 (CAD$69,500) pay an additional £325 (CAD$560) a year for five (5) years starting with the second year the vehicle is taxed. Over time, the tax on low-polluting vehicles has fallen, while that on more-polluting vehicles has increased – resulting in a steeper slope to the tax curve as vehicle emissions increase. ZEVs and low-emission vehicles below 50g $CO_2$/km are tax exempt (from April 2018 until March 2021).

Figure 19: Vehicle GHG Pricing Schedule - United Kingdom (2017 onwards)
First Year of Circulation Tax

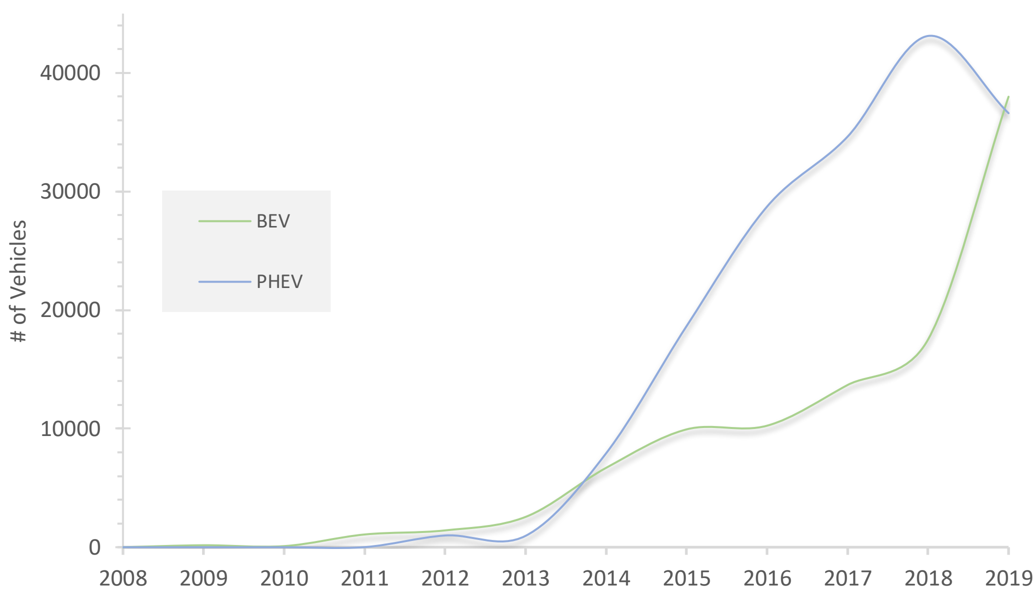



Data source: UK Government, 2020.
Negative values represent rebates.

The UK offers rebates based on a vehicle's end use. Passenger vehicles with emissions below 50g $CO_2$/km, an emission-free range of at least 70 miles (112 km) and a retail value of up to £50,000 (CAD$87,000), are eligible for rebates of up to £3,000 (CAD$5,200) and 35 per cent of a vehicle's retail value. Vans with emissions of less than 75g $CO_2$/km and an emission-free range of at least 10 miles (16 km) are eligible for rebates of up to £8,000 (CAD$14,000) and 20 per cent of their retail value. Motorcycles with an emission-free range of 31 miles (50 km) and mopeds with an emission-free range of 19 miles (30 km) are eligible for rebates of up to £1,500 (CAD$2,600) and 20 per cent of their retail value. In addition, the UK also offers rebates for lower-emitting commercial vehicles. Large vans and trucks with $CO_2$ emissions of at least 50 per cent of a comparable vehicle meeting European emission standards 4 and an emission-free range of at least 10 miles (16 km) are eligible for rebates of up to £20,000 (CAD$35,000) and 20 per cent of a vehicle's retail value for the first 200 orders and £8,000 (CAD$14,000) for orders thereafter. Taxis with emissions of less than 50g/km and emission-free range of at least 70 miles (112 km) are eligible for rebates of up to £7,500 (CAD$13,000) and 20 per cent of the vehicle's retail value.

The increased stringency of the bonus-malus scheme has contributed to the rise of BEVs and PHEVs in the UK (see Figure 20). Noticeable is a sharp drop in PHEV sales, and based on preliminary data for 2020, ZEVs are likely to exceed peak PHEV registrations despite the economic downturn resulting from the COVID-19 pandemic. Although other variables should be considered (e.g., high fuel prices), the upward trend in ZEV sales corresponds in part with the new stringency of fees implemented in 2017.

*Figure 20: New Alternative Fuel Vehicles Registered – United Kingdom*




Data source: European Alternative Fuels Observatory, 2020.

# 3. A Vehicle Feebate System for Canada

As noted in the previous sections, considered together, Canada's iZEV and Green Levy programs provide limited coverage, do not have the stringency required to decarbonize the country's LDV segment, and lack the benefits associated with a consolidated program such as a feebate system. The experience of other jurisdictions in bonus-malus programing provide important examples of the kinds of initiatives that can create market conditions more favourable to low carbon mobility. Although fees for new ICE vehicles can be set as aggressively as other jurisdictions to induce a more rapid transition to lower carbon alternatives, the more practical approach would be to start with gradual increases that cover the majority of vehicle models, and adjust the slope of the rate over time. Even a modest initial fee rate can have an impact, as demonstrated by a study of Ontario's feebate that found a fee of $1,000 resulted in the market share of a vehicle to decline by 30 to 40 per cent (Rivers & Schaufele, 2017).

Consumers in the European Union have over time become accustomed to high registration fees on ICE vehicles, and governments have been able to use reduced taxation to incentivize uptake of ZEVs. Norway offers one of the most generous tax breaks in a jurisdiction that has seen the highest ZEV market penetration (at about half of all new vehicles registered, more than any other jurisdiction), and it intends to use fiscal measures to achieve its 2025 ZEV target of 100 per cent. Reverse incentives through lower taxes for ZEVs are effective when consumers in a jurisdiction are accustomed to higher vehicle $CO_2$ taxes.

In the case of Canada, where fuel prices remain low and most vehicles are largely exempt from the country's Green Levy program, a transitionary period would be required to allow a degree of comfort and familiarization with $CO_2$-based taxation. In the interim, as Melton et al. (2020) argue, subsidies such as rebates provide the option for the government to 'spend their way to ZEV targets without tightly regulating automakers or imposing undue cost burden on consumers'. Larger rebates for ZEVs in the short-term can also be designed in a way to support lower-emitting ICE vehicles for consumers who are not ready to purchase a ZEV (*c.f.,* Cambridge Systematics, 2019). Such an approach will only be successful when incentives are both high value and are sustained over the long-term.

The three (3) different recommended approaches in implementing a Canadian vehicle feebate system are presented below. Two (2) of these options can be advanced through a redesign and consolidation of Canada's Green Levy and iZEV programs. The second option presented below would require an all new approach and is likely to take longer to implement.

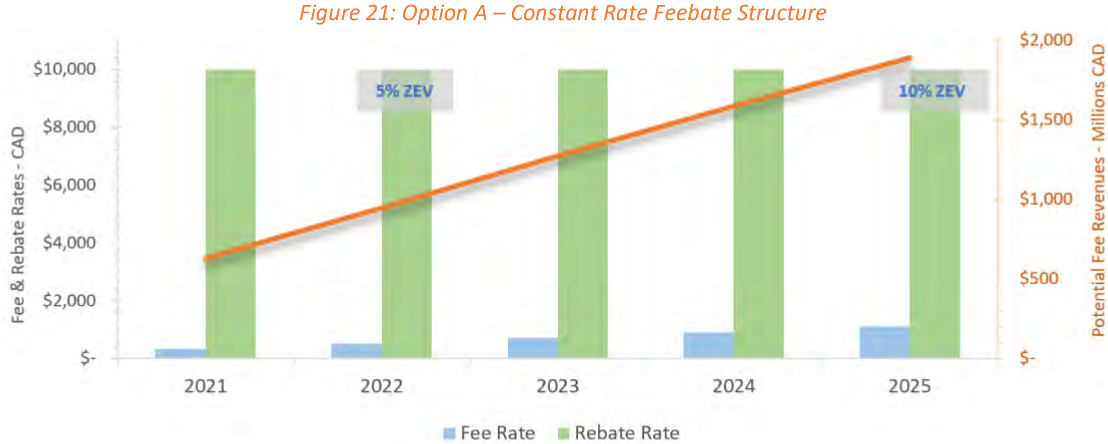
The first option is a constant rate feebate system with a set fee that applies to all ICE vehicles, increasing annually, and revenues collected are then offered through ZEV rebates. The second option offers a feebate system that is comparable to a circulation tax with the difference that it would be partially administered by automobile insurance companies. The fee portion would consider a vehicle's emission intensity, distance of travel between work and home, and annual mileage, and would be applied through insurance policies. Fees collected would then be transferred to the government, which would use the funds for point-of-sale rebates for ZEVs. The third and recommended option is a system whereby both fees and rebates are determined based on vehicle emissions. The fees would be set based on an exponential function correlated to vehicle emissions and would increasingly become more stringent over time. Comparable to the first approach, fees collected would be used to fund the rebate program but unlike a constant rate feebate system, it is recommended that Canada initiate with a higher rebate program and adjust the fees over time with the aim of achieving cost recovery in future years.

Although each of the options below have their unique benefits, a combination of the latter two are likely to have the most impact in accelerating the transition to lower carbon mobility and would be most effective in supporting Canada's ZEV targets.

## 3.1 Option A – Constant Rate Feebate System

One approach would be to apply a set fee to all ICE vehicles, irrespective of their emissions. For example, a fee of $1,000 applied to all ICE vehicles currently sold in Canada will generate near $1.8 billion in revenues annually. These revenues can then be recycled as a rebate to consumers purchasing ZEVs, with rates correlated to government ZEV targets. This way, the fee rate would gradually increase while rebates are kept static as markets respond with increased ZEV uptake (see Figure 21). For example, with an interim ZEV target of 5 per cent, the fee rate can be set at approximately $500 per vehicle in 2022, resulting in rebates of about $10,000. The ICE fees would then gradually increase to $1,000 by 2025, which would result in the same level of rebates of $10,000 for ZEV target of 10 per cent. This assumes a constant rate of new vehicle registration, and the government would only adjust the rates for the fee portion while keeping the rebate rates constant.

*Figure 21: Option A – Constant Rate Feebate Structure*




A constant rate of rebates would provide increased market certainty for ZEV manufacturers while incrementally increasing fee rates would make ICEs in general more expensive over time. Although such an approach would be truly revenue neutral, it would not disincentivize higher-emitting ICEs and would disproportionately penalize lower-cost and lower-emitting ICEs over more expensive and higher-emitting vehicles such as luxury vehicles, SUVs, and larger trucks.

## 3.2 Option B – Circulation Feebate System

Although there are no circulation taxes in Canada, many jurisdictions collect such fees on an annual basis and case studies reviewed in this report provide examples of how circulation taxes can be tied to vehicle emissions. Canada could pursue a novel approach of applying a circulation fee through vehicle insurance policies. The government would set the fee rate and insurance companies would in turn collect the fees on behalf of the government. The fees would consider a vehicle's $CO_2$ per kilometer emissions, and it could also include other factors such as annual millage and distance of travel between home and work (when a vehicle is used for the purpose of commuting to work). Given Canada's vehicle fleet make up, an exponential function rate to disincentivize higher-emitting SUVs and trucks would be recommended, while lower-emitting vehicles would benefit from lower fees and ZEVs would be exempt from the additional surcharge altogether.

Automobile insurance companies already collect much of the information needed to deliver such program, which would come at low administrative costs as compared to a circulation fee collected directly by governments. This approach would also send a market signal on preferential insurance rates for lower-emitting vehicles and incentivize consumers to consider longer-term insurance costs as part of their vehicle purchasing decisions. Although it would be novel in its application through a third party, it would be comparable to emissions-based circulation fees in other jurisdictions. The inclusion of distance of travel would also be comparable to the methodology used to calculate tax benefits associated with private use of corporate vehicles.

Fees collected would be transferred to the federal government, which in turn would use such revenues to provide ZEV rebates. For reasons noted in Option A, the rebate rates should remain constant and the government can determine the number of rebates it can issue based on fees collected in the previous fiscal year or on more frequent increments (e.g., monthly, biannual).

## 3.3 Option C – Emissions-Based Feebate System

The most effective feebate systems consider vehicle emissions, with predictable fees and rebates that can help to improve market certainty for both consumers and manufacturers. The proposed approach would apply a single-class continuous-function fee structure that has the broadest possible emissions coverage and with stringency that increases over time. It would apply fees and offer rebates that are comparable to the rates of leading jurisdictions, expand rebate program that covers the used-vehicle market, and incorporate additional benefits for scrappage of used ICE vehicles when purchasing a ZEV. Furthermore, the proposed approach would take into consideration the purchaser's net household income, with higher incentives offered to lower-income consumers.

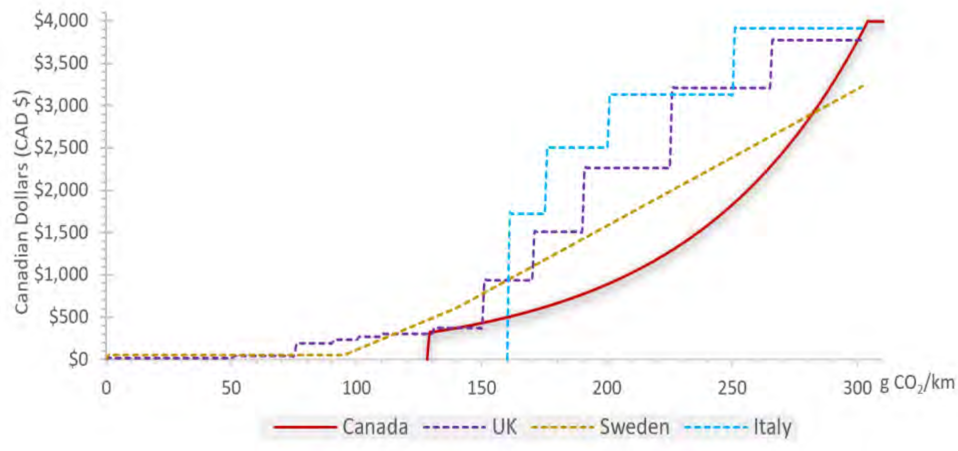
### 3.3.1 Fees – Slope Rate and Structure

There are three (3) fee slope rate structures that Canada could choose from: step-, linear- and exponential functions. The first two (2) models are easier to communicate, while a key weakness of the step-function is the unequal level of incentives it offers across an emission range. Although the exponential-function slope rate structure may be more difficult to communicate, it is a superior model compared to the linear function, since it applies a significantly higher rate and therefore is biased against higher-emitting vehicles. The exponential model may be particularly effective in the Canadian context, which requires an approach for reversing the current purchasing trend of larger and heavier vehicles. Making ZEVs and more fuel-efficient vehicles more cost attractive can play pivotal role in shifting demand away from more polluting vehicles. In its initial implementation, an exponential-function structure can also be designed with marginal rates, to ensure coverage for a wider range of vehicles with lower emissions, and in turn, to minimize the cost burden of such a policy during the post-pandemic recovery period.

Canada's current Green Levy program starts at $1,000 starting at 302 g $CO_2$/km. In the near-term, it is recommended that Canada revise the Green Levy program to a continuous-function fee structure, with a moderately low rate (approximately $300) that starts at the minimum average fleet emissions of 127g $CO_2$/km and increases gradually to $1,000 at 206g $CO_2$/km (the average emission intensity of Canada's LDV sector).

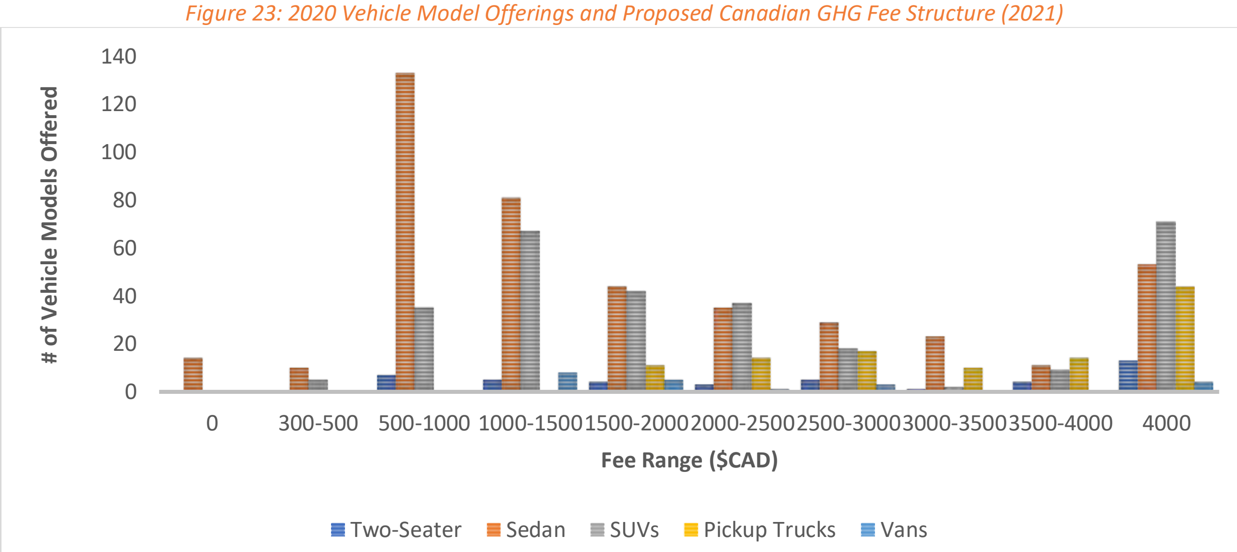
The proposed approach approximates the rates of comparable policies in the UK, Italy, and Sweden (see Figure 22). Several European jurisdictions apply a differentiated rate for gasoline and diesel. A single fee schedule should be based on actual tailpipe $CO_2$ emissions (which would be determined irrespective of fuel type), and such approach would be easier to administer and communicate as part of Canada's climate policy. Other environmental concerns (e.g., NOx, PM) can be addressed through separate regulations.

*Figure 22: Proposed Canadian Vehicle GHG Fee Structure Versus Other Jurisdictions (2021)*



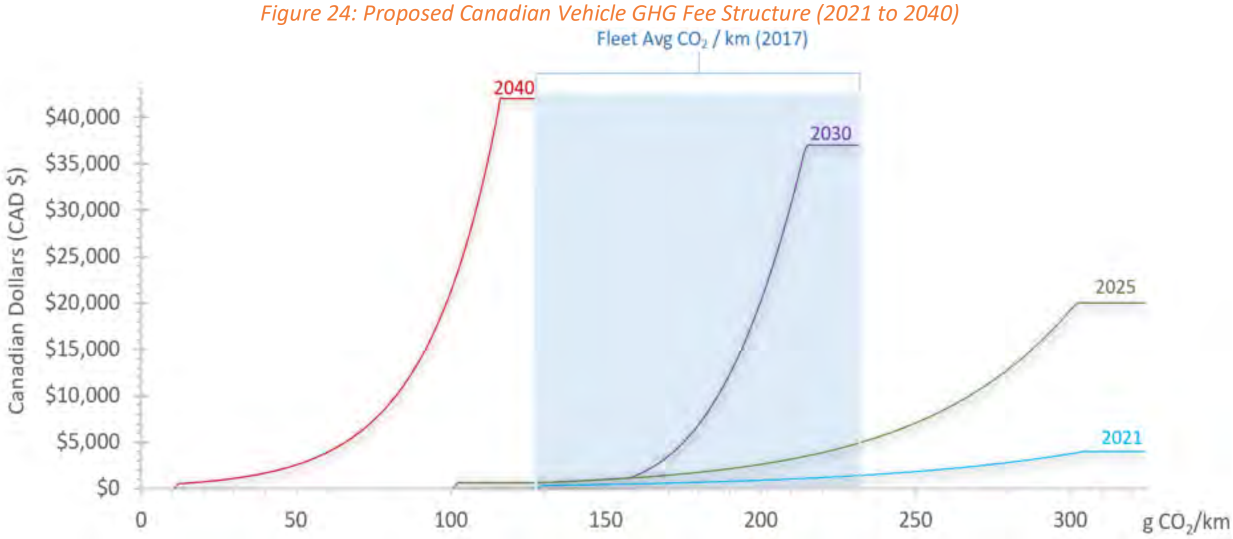

The proposed approach would put one third of passenger sedan model offerings (i.e., subcompact, mini-compact, compact, mid- and full-size, and station wagons) between the two (2) price bands while the majority of smaller SUVs and larger family sedans would pay a fee of less than $2,000 (set at 254g $CO_2$/km). The maximum fee rate of $4,000 (set at a threshold of 302g $CO_2$/km) would apply mainly to larger trucks, luxury, and high-end sports vehicles. A review of 2020 vehicle model offerings indicates that there are passenger vehicle model offerings across the proposed fee bands (with the notable exception of light trucks), providing consumers with the choice of selecting lower-emitting vehicles in order to pay less $CO_2$-based fees or to avoid such fees altogether (see Figure 23).

*Figure 23: 2020 Vehicle Model Offerings and Proposed Canadian GHG Fee Structure (2021)*




The proposed approach would represent a significant improvement to the current structure of the Green Levy program, and its initial low rates for a large segment of the vehicle market would minimize public criticism, particularly with the companion program of rebates for lower-emitting vehicles. That said, for the feebate system to support Canada's longer-term ZEV targets, the stringency of the fees must be increased over time. From 2021 to 2030, the slope of the fee rate should gradually increase, and from 2030 to 2040 – the year Canada aims for a 100% ZEV market penetration in its LDV segment – the slope rate would discourage the sale of any ICEs (see Figure 24). The proposed fee structure in 2030 would be comparable to that of France's current fee structure[5] and would have a broader coverage of lower-emitting vehicles. The gradual change in the fee structure should provide automobile manufacturers with sufficient time to make appropriate technology investment decisions while incentivizing a shift to Canadian model offerings of mainly low-carbon vehicles. European jurisdictions with comparably stringent fee structures for higher-emitting vehicles have seen their average vehicle emissions decrease, with France achieving an average emission profile of 126g $CO_2$/km, 39 per cent below that of Canada's.

*Figure 24: Proposed Canadian Vehicle GHG Fee Structure (2021 to 2040)*




## 3.3.2 Fees – Vehicle Classification

Feebates can apply a single fee structure to all vehicles, or consider vehicle classifications using types and/or footprint for grouping similar vehicles together – such as double pivot points (one for passenger vehicles, one for light-duty trucks), and multiple pivot points (e.g., segmenting light trucks, vans, sport utility vehicles, and two-wheel vehicles) (*c.f.,* Cambridge Systematics, 2019). However, vehicle classification is challenging, and the 'crossover' class, for example, may be composed of body styles built on either car or truck platforms, with some models identified as cars and others as light trucks.

Although multiple class-based fee structures can mitigate the competitiveness concerns of vehicle manufacturers, this approach risks giving preferential treatment to larger and higher-emitting vehicles at the expense of a lower-emitting option in another class. The extent of the disparities between manufacturer fuel economies will be mainly a result of product distribution by class, and a feebate will not significantly increase sales of some manufacturers' vehicles at the expense of others (Langer, 2005: 8). Moreover, Greene et al. (2005) found that a feebate can only affect market shifts between vehicle classes to a small degree, even in a single pivot-point scheme. This possibility implies that the benefits of the feebate are largely independent of the number of pivot points that define it. However, the risk persists and is relevant for the Canadian market especially, owing to how a shift towards light truck purchases has meant that light trucks now comprise three quarters of new vehicle sales in Canada. Given the absence of

[5] Adjusted to an inflation rate of 1.7 per cent over the next ten (10) years.

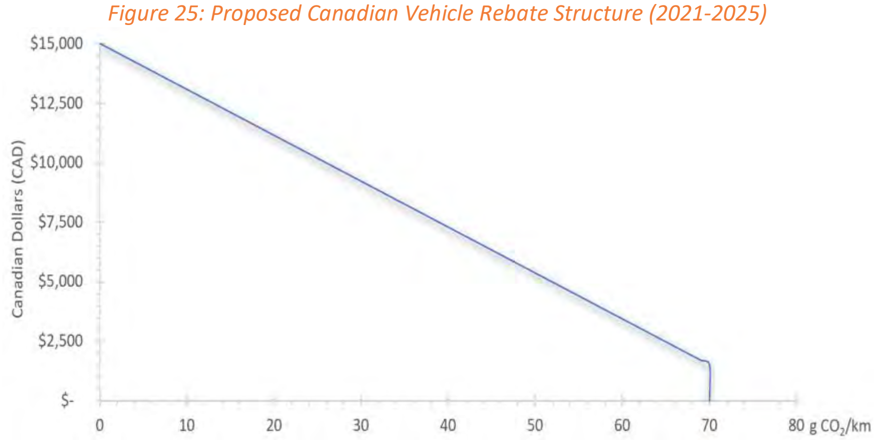
significant benefits attached to multiple fee structures as well as the potential risks of reduced environmental benefits, a single fee structure will be more effective in offering the widest coverage of new vehicles sold.

It is also important to note that, by its very design, a feebate system must be biased against higher-emitting vehicles; in so doing, it may be inevitable that emission-based taxes will add undue costs to consumers that require light trucks for work purposes. The 2020 and 2021 light trucks model offerings in Canada have an emission profile starting from 238 to 342g $CO_2$/km for larger engine four-wheel drive versions. In the initial year of the proposed system, consumers of such vehicles will be required to pay a fee of between $2,000 to $4,000, specifically because lower-carbon alternatives do not yet exist. Rather than a straight exemption, the policy could allow for 100 per cent capital tax write-offs for light trucks purchased for specified work purposes (e.g., in agriculture, construction, industrial activities) until lower-carbon alternatives are market-ready.

### 3.3.3 Rebates – Slope Rate and Structure (New Vehicles)

To remain competitive with leading jurisdictions and incentivize the market availability of a wider range of ZEV models, Canada should redesign its ZEV rebates with higher rebates based on a continuous function, offered at the point of sale (see Figure 25).

*Figure 25: Proposed Canadian Vehicle Rebate Structure (2021-2025)*




More specifically, Canada should:

- Begin negotiations with the automobile manufacturers with the objective of offering higher rebates for lower-emitting vehicles, through a 1:3 industry-government cost-shared program;
- Increase the maximum rebate rate to CAD$15,000 (or $10,000 without industry rebates);
- Correlate the rebate program with vehicle emission profiles from zero to 70g $CO_2$/km;
- Require retailers to make the rebate value clearly visible to consumers;
- Offer additional incentives to rebate recipients who scrap an ICE vehicle in the process; and,
- Issue rebates by cheque or direct deposit within six (6) months after the vehicle buyer has registered the eligible ZEV or PHEV in their respective province.

### 3.3.4 Rebates – Slope Rate and Structure (Used Vehicles)

Although extending a feebate program to the used-vehicle market does not necessarily result in ZEV additionality (Cambridge Systematics, 2019: 37), it can expedite the retirement of ICEs. Germany offers rebates of about CAD$5,800 and $7,800 for used PHEVs and BEVs, respectively. The Netherlands used ZEV rebates of CAD$3,100 and extended additional eligibility requirements, including vehicles in a retail price range of about CAD$19,000 to $70,000 and a minimum emission-free range of 120 km. Incorporating an emissions-based rebate program for the used-vehicle market (as suggested for the new-vehicle market) will be complex and can create unnecessary administrative burden.

For the used ZEV and PHEV segment, Canada should:

- Set separate maximum rebate rates for used ZEVs and PHEVs;
- Set a maximum percentage value for the rebate in relation to the market value of a vehicle;
- Require that eligible vehicles have an emission-free range of at least 120 km; and,
- Issue rebates by cheque or direct deposit within twelve (12) months after the vehicle buyer has registered the eligible ZEV or PHEV in their respective province.

### 3.3.5 Rebates – Equity

The cost of most ZEVs and PHEVs is comparatively higher than ICE vehicles, even with rebates factored in, and as a result, the new segment of such vehicles remain primarily accessible to higher-income consumers and multicar households. This income group is less likely to consider rebates in their purchasing decisions, and the current cap on vehicle retail price under the iZEV program would be insufficient to prevent program access by individuals who do not require a federal subsidy in their ZEV and PHEV purchases. Moreover, the rebate program should not further widen income inequality, especially against the backdrop of a changing climate that disproportionately affects lower-income individuals who are more likely to drive older ICE vehicles and will in turn not benefit from fuel and operating cost savings associated with ZEVs.

A study of California's feebate programming found that straight rebates will primarily benefit higher-income households (Bunch et al., 2011). The State has since revised its Clean Vehicle Rebate Program to include income considerations, with promising early results (*c.f.,* PIEEE-UCDavis, 2019). The State has seen an increase by low- and moderate-income consumers accessing the ZEV rebate program, from about 5 per cent in 2016 to 10 per cent in 2017. Although consumers with income of over $300,000 received about 2 per cent of rebates (down from 15 per cent), those with incomes of over USD$100,000 continue to remain the recipient of about a quarter of program rebates.

To ensure that a federal feebate system is effective, supports electric vehicle uptake by the widest segment of the population, and does not widen the income inequality, Canada should:

- Set an iZEV eligibility cap of $122,800 (200 per cent of median income after taxes) or lower;
- Target the rebates for lower- and middle-income individuals, preferably on a geared-to-income basis; and

- Mandate the Canadian Revenue Agency to administer the new combined Green Levy and iZEV programs, with the support of Environment and Climate Change Canada, Transport Canada, and Natural Resources Canada.

## Concluding Remarks

Sticker value of a vehicle is likely to have a more direct impact on purchasing decisions than longer-term cost considerations. According to our analysis, Canadians pay between $26,000 and $35,000 for fuel over the life of a vehicle. In turn, through fuel cost savings, increased ZEV market penetration would have an indirect effect on consumer purchasing power for goods and services over the longer term. However, vehicle purchasing decisions typically deviate from the predictions of standard rational choice models, and as Langer (2005) has observed, consumers do not necessarily discount the lifetime fuel cost savings as part of their assessment of vehicle choices. Fees that increase the cost of higher-emitting vehicles and rebates that make ZEV more attractive at the point of purchase are likely to have a greater impact on purchasing decisions than information on fuel costs and vehicle GHGs on their own.

This report provides three (3) different approaches for introducing a true feebate system, where the first two (2) options would impose a marginal fee while the third and recommended approach would gradually increase fees over time, allowing for improved consumer awareness of the fee system. This report recognizes the difficulties associated with imposing higher fees on more polluting vehicles in the Canadian context. Nevertheless, other jurisdictions with high vehicle ownership fees tied to environmental factors have had a long history with such measures and consumers are generally accustomed to higher fee schemes. A Canadian feebate system can gradually increase in its stringency as markets respond and consumers become increasingly aware of fee and rebate structures.

A cohesive system that ties fees and rebates would have the benefit of not only being self-funded but would also allow decision makers to adjust fee and rebate stringencies in concert and towards a common policy objective. To this end, Canada can reform its Green Levy and iZEV programs into a cohesive feebate system. In so doing, it should not wait until there is sufficient revenues from a reformed Green Levy program to increase ZEV rebates. Rather, as part of post-pandemic recovery plans, Canada should immediately increase iZEV rebate rates to align with the range of incentives offered by leading jurisdictions. The rates could then be adjusted as the market responds and the government could pursue cost recovery by increasing the fees for polluting vehicles over time. Higher fees and lower rebates will also become more viable with an increase in lower-cost ZEV model offerings across vehicle classes.

Although a very stringent feebate system can drive decarbonization in the LDV segment, they should be introduced gradually and complemented with other government measures. For example, Canada could pursue a national ICE vehicle scrappage program that is tied directly to the purchase of new or used ZEV (as noted in 3.3). The federal government could also offer, as recommended by the Task Force for Resilient Recovery, dedicated funding to support manufacturing of ZEVs. Any capital incentives provided to the automobile manufacturers as part of the post-pandemic recovery plan should have green strings attached and ensure that government investment rather supports and does not undermine Canada's climate objectives. Although Canada has made significant investment in ZEV charging and fueling infrastructure, these efforts should also be scaled up as demand for ZEVs increases. Finally, perhaps the most impactful policy tool is a ZEV mandate, and such measure can be introduced alongside more stringent vehicle GHG regulations. *Taken together, the perfect public policy reform would include (1) a national feebate system that increases in stringency over time, (2) ICE vehicle scrappage incentives directly tied to ZEV purchases, (3) capital incentives for ZEV manufacturers, (4) additional investment in ZEV charging and fueling infrastructure, (5) a national ZEV mandate and (6) more stringent vehicle GHG regulations.*

# Bibliography


ACEA - European Automobile Manufacturers Association (2019). *Electric Vehicles: Tax Benefits & Incentives in the EU*. Retrieved from: https://www.acea.be/uploads/publications/Electric_vehicles-Tax_benefits_incentives_in_the_EU-2019.pdf

Antweiler, W. and Gulati, S. (2013). "Market-based Policies for Green Motoring in Canada". *Canadian Public Policy* 39 Supplement: S81-S94.

Axsen, J., & Wolinetz, M. (2018). "Reaching 30% plug-in vehicle sales by 2030: Modeling incentive and sales mandate strategies in Canada". *Transportation Research Part D: Transport and Environment* 65: 596-617. doi:10.1016/j.trd.2018.09.012

Banerjee, R. (2007). *Deals on Wheels: An Analysis of the New Federal Auto Feebate.* C.D. Howe Institute.

Belastingdienst - The Dutch Tax and Customs Administration (2020). *Bpm-tarief personenauto*. Nederlandse regering. (Retrieved from https://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/auto_en_vervoer/belastingen_op_auto_en_motor/bpm/bpm_berekenen_en_betalen/bpm_tarief/

Bjerka, K. Y., Nørbech, T. E., & Nordtømme, M. E. (2016). "Incentives for promoting Battery Electric Vehicle (BEV) adoption in Norway". *Transportation Research Part D: Transport and Environment* 43: 169-80. doi:10.1016/j.trd.2015.12.002

Bunch, D. S., Greene, D. L., Lipman, T., Martin, E., & Shaheen, S. (2011). *Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California.* Davis: University of California. Retrieved from: https://trid.trb.org/view/1107746

Buzzell, M. (2019). "Ford Electric 2020: Canadians on the verge of having more electrified vehicle choices". Retrieved from: https:// www.ford.ca/innovation/ford-electric-2020

Cambridge Econometrics. (2013). *The effectiveness of CO2 – based 'feebate' systems in the European passenger vehicle market context: An analysis of the Netherlands and the UK.* Cambridge: Cambridge Econometrics.

Cambridge Systematics. (2019). *Vehicle Feebate and Vehicle Incentive Programs Funding Report.* Vermont Agency of Transportation.

CBC – Canadian Broadcasting Corporation (2017). "GM plans to add 20 new electric, fuel cell vehicles to lineup by 2023." Retrieved from: https://www.cbc.ca/news/business/general-motors-electric-fuel-cell-1.4316655

Consultants, M. R. (2005). *Development of Options for a Vehicle Feebate in Canada.* Ottawa: Marbek Resource Consultants, Resources for the Future, and DesRosiers Automotive Consultants.

Durrmeyer, I., & Samano, M. (2017). "To Rebate or Not to Rebate: Fuel Economy Standards Versus Feebates". *The Economic Journal* 128 (616): 3076–3116. doi:10.1111/ecoj.12555

Engström, E., Algers, S., & Hugosson, M. B. (2019). "The choice of new private and benefit cars vs. climate and transportation policy in Sweden". *Transportation Research Part D: Transport and Environment* 69: 276-92. doi:10.1016/j.trd.2019.02.008

ECCC - Environment and Climate Change Canada (2018). *Greenhouse Gas Emissions Performance for the 2017 Model Year Light-Duty Vehicle Fleet.*

Evarts, E.C. (2019). "BMW pulls ahead its electrification plans by two years". Green Car Reports. Retrieved from: https://www.greencarreports.com/news/1123785_bmw-pulls-ahead-its-electrification-plans-by-two-years

Fridstrøm, L., & Østli, V. (2017). "The vehicle purchase tax as a climate policy instrument". *Transportation Research Part A: Policy and Practice* 96: 168-89. doi:10.1016/j.tra.2016.12.011

Korosec, K. (2017). "Briefing: Toyota Plans to Roll Out 10 All-Electric Vehicles". Retrieved from: http://fortune.com/2017/12/18/toyota-electric-vehicle-strategy

German, J., & Meszler, D. (2010). *Feebate Review and Assessment: Best Practices for Feebate Program Design and Implementation.* International Council on Clean Transportation (ICCT). Retrieved from: https://theicct.org/sites/default/files/publications/ICCT_feebates_may2010.pdf

Gouvernement de la République française. (2019, December). LOI n° 2019-1479 du 28 décembre 2019 de finances pour 2020. Retrieved from Légifrance: https://www.legifrance.gouv.fr/eli/loi/2019/12/28/CPAX1925229L/jo/texte

Skatteforvaltningen – Danish Customs and Tax Administration. (2020). Den juridiske vejledning 2020-2: I.A.1.4.2 Personbiler og motorcykler. Retrieved from https://skat.dk/skat.aspx?oid=1947291

Greene, D.L., Patterson, P.D., Singh, M., & Li, J. (2005) "Feebates, rebates and gas-guzzler taxes: a study of incentives for increased fuel economy". *Energy Policy* 33 (6): 757-75. doi:10.1016/j.enpol.2003.10.003.

Habibi, S., Hugosson, M. B., Sundbergh, P., & Algers, S. (2016). *Car fleet policy evaluation: the case of a Bonus-Malus system in Sweden (CTS Working Paper 2016:19).* Stockholm: Centre for Transport Studies.

IEA - International Energy Agency (2019a). *Tracking Transport 2019 - Electric Vehicles*. Paris: IEA. Retrieved from: https://www.iea.org/reports/tracking-transport-2019/electric-vehicles#

IEA (2019b). *Global EV Outlook 2019*. Paris: IEA. Retrieved from: http://www.iea.org/publications/reports/globalevoutlook2019

IEA. (2019c). Fuel Economy in Major Car Markets: Technology and Policy Drivers 2005-2017. Paris. IEA. Retrieved from: https://webstore.iea.org/fuel-economy-in-major-car-markets

IMF - International Monetary Fund (2019). *Fiscal Monitor: How to Mitigate Climate Change.* Washington, D.C.: International Monetary Fund.

Lienert, P. and Chan, C. (2019). "A Reuters analysis of 29 global automakers found that they are investing at least $300 billion in electric vehicles, with more than 45 percent of that earmarked for China". Retrieved from: https://graphics.reuters.com/AUTOS-INVESTMENT-ELECTRIC/010081ZB3HD/index.html

Jenn, A. (2019). *Lessons Learned for Designing Programs to Charge for Road Use, Congestion, and Emissions (A White Paper from the National Center for Sustainable Transportation).* Davis,CA: University of California.

Klier, T., & Linn, J. (2012). "Using vehicle taxes to reduce carbon dioxide emissions rates of new passenger vehicles". Resources for the Future Discussion Paper, August. Retrieved from: http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=220 13

Langer, T. (2005). *Vehicle Efficiency incentives: An update on feebastes for states.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Melton, N., Axsen, J., & Moawad, B. (2020). "Which plug-in electric vehicle policies are best? A multi-criteria evaluation framework applied to Canada". *Energy Research and Social Science* 64, doi:10.1016/j.erss.2019.101411

Mims, N., & Hauenstein, H. (2008). *Feebates: A Legislative Option to Encourage Continuous Improvements to Automobile Efficiency.* Rocky Mountain Institute.

Mock, P. (2016). "The Power of Vehicle Taxation Schemes". ICCT blog post, 18 August. Retrieved from: https://theicct.org/blogs/staff/the-power-of-vehicle-taxation-schemes

NRCan - Natural Resources Canada (1999). *Assessment of a Feebate Scheme for Canada*. Prepared by HLB Decisions Economics Inc.

OECD (2019). *Are environmental tax policies beneficial? Learning from programme evaluation studies.* Organisation for Economic Co-operation and Development.

OECD (2001). "Pigouvian tax". *OECD Statistical Portal, Glossary of Statistical Terms*. Retrieved from: https://stats.oecd.org/glossary/detail.asp?ID=2065

PIEEE-UCDavis (2019). *Impact of the Clean Vehicle Rebate Project's increased rebates for low- and moderate-income individuals on California's ZEV Market (Whitepaper for the California Air Resources Board).* Davis, CA: Policy Institute for Energy, Environment, and the Economy, University of California. Retrieved from: https://policyinstitute.ucdavis.edu/wp-content/uploads/CVRP_Rebates_0519.pdf

Rivers, N., & Schaufele, B. (2017). “New Vehicle Feebates”. *Canadian Journal of Economics/Revue Canadienne d’économique* 50 (1): 201–32. doi: 10.2139/ssrn.2491552

Schroten, A., Aarnink, S., Gardiner, B., Szewczyk, W. and Mittal, S. (2014). *User Guide – Feebate Simulation Tool*. CE Delft for the International Council on Clean Transportation (ICCT) and the Global Fuel Economy Initiative (GFEI). Retrieved from: https://theicct.org/feebate-simulation-tool

Transportstyrelsen - Swedish Transport Agency (2020) “Bonus malus-system för personbilar, lätta lastbilar och lätta bussar.” Retrieved from: https://www.transportstyrelsen.se/sv/vagtrafik/Fordon/bonus-malus/

Tietge, U. (2017). “Lessons learned from Sweden’s electric vehicle rollercoaster”. ICCT blog post, 14 February. Retrieved from: https://theicct.org/blog/staff/lessons-learned-sweden-EV-rollercoaster

Tietge, U. Mock, P., Lutsey, N. & Campestrini, A. (2016). *Comparison of leading electric vehicle policy and deployment in Europe*. Retrieved from: http://www.theicct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf

UK Government (2020). “Vehicle tax rates” and “Low-emission vehicles eligible for a plug-in grant”. Retried from: https://www.gov.uk/vehicle-tax-rate-tables and https://www.gov.uk/plug-in-car-van-grants

Wappelhorst, S. (2020, January 16). Actions speak louder than words: the French commitment to electric vehicles. Retrieved from ICCT: https://theicct.org/blog/staff/actions-speak-louder-words-french-commitment-electric-vehicles

Wappelhorst, S. & Tietge, U. (2018). “Sweden’s new bonus-malus scheme: From rocky roads to rounded fells?”. ICCT blog post, 8 October. Retrieved from: https://theicct.org/blog/staff/swedens-feebate-system-20181008

World Bank Group (2019). *State and Trends of Carbon Pricing*. Washington: World Bank. Retrieved from: https://elibrary.worldbank.org/doi/pdf/10.1596/978-1-4648-1435-8

Yang, Z. (2018a). *Vehicle Fuel Economy Standards and Feebate System. Presentation to the ACEEE International Symposium on Energy Efficiency.* Washington, D.C.: The International Council on Clean Transportation.

Yang, Z. (2018b). “Practical lessons in vehicle efficiency policy: The 10-year evolution of France’s CO2 – based bonus-malus (‘feebate’) system”. ICCT blog post, 12 March. Retrieved from: https://theicct.org/blog/staff/practical-lessons-vehicle-efficiency-policy-10-year-evolution-frances-co2-based-bonus