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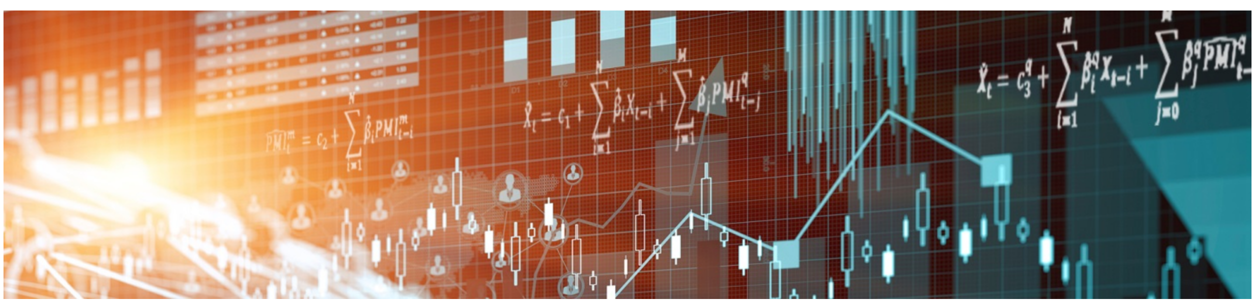
Outlook for Electric Vehicles and Implications for the Oil Market



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Abstract

The market for electric vehicles (EVs) is growing rapidly. Subsidies and technological improvements are expected to increase the market share of EVs over the coming decade. In its base-case scenario, the International Energy Agency (IEA) expects EV use to rise from 4 million vehicles in 2018 to 120 million by 2030, or from 0.3 per cent to over 7 per cent of the global car fleet. However, depending on environmental policy decisions, the number of EVs on the road by 2030 could reasonably range between 57 million and 300 million (4 to 19 per cent of the global fleet). The switch to EVs will have important implications for the global oil market. Our analysis shows that for every additional 100 million EVs on the road in 2030, gasoline consumption would fall by about one million barrels of oil per day and oil prices would be 4 per cent lower. Applying this rule-of-thumb to IEA's base-case oil price projection of US$90 for 2030, we find that different assumptions on the size of the EV fleet can reasonably push oil prices within a range of US$85 to US$93.

Bank topic: International topics
JEL codes: Q4, Q47

Résumé

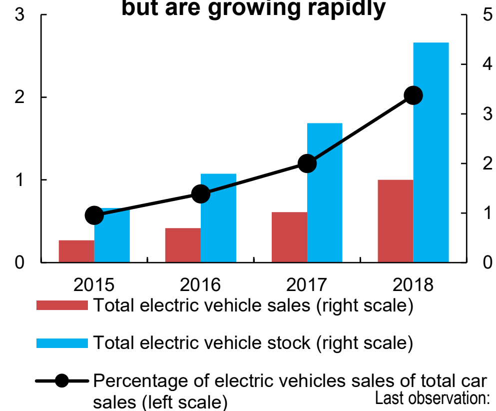
Le marché des véhicules électriques (VE) est en forte croissance, et grâce aux subventions et aux avancées technologiques, la part de marché de ces véhicules devrait encore augmenter au cours de la prochaine décennie. Dans son scénario de référence, l'Agence internationale de l'énergie (AIE) prévoit que le nombre de VE utilisés passera de 4 millions en 2018 à 120 millions en 2030, soit de 0,3 % à plus de 7 % du parc automobile mondial. Cela dit, selon les décisions qui seront prises en matière de politiques environnementales, il pourrait y avoir entre 57 et 300 millions de VE sur les routes en 2030 (soit entre 4 % et 19 % du parc automobile mondial). Le passage aux VE aura d'importantes répercussions sur le marché mondial du pétrole. Notre analyse montre que pour chaque tranche de 100 millions de VE de plus sur les routes en 2030, la consommation d'essence chuterait dans une proportion équivalente à environ un million de barils de pétrole par jour, tandis que les prix du pétrole baisseraient de 4 %. En appliquant cette règle empirique au prix du pétrole retenu dans le scénario de référence de l'AIE (90 $ US en 2030), nous constatons que, selon les différentes hypothèses utilisées quant à la taille du parc de VE, les prix du pétrole s'inscriraient vraisemblablement dans une fourchette allant de 85 à 93 $ US.

Sujet : Questions internationales
Codes JEL : Q4, Q47

1. The number of electronic vehicles is expected to grow rapidly through 2030

The market for electric vehicles (EVs) is growing rapidly. Annual EV sales have quadrupled since 2014 to over 1.5 million units. Despite this steep increase, EV sales still account for only 2 per cent of new car sales and less than 0.3 per cent of the world's 1.1 billion stock of passenger cars (**Chart 1**).[1] China is by far the world's largest market for EVs—accounting for about half of global sales in 2018. The rapid penetration of EVs is partly a result of generous government incentives, both to producers and to consumers, as Chinese policy-makers seek to tackle pollution-related issues.

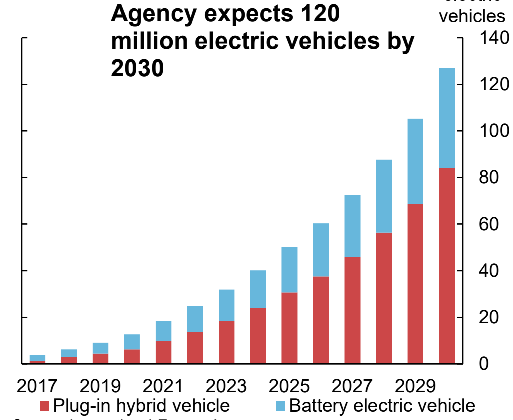
Chart 1: Electric vehicles are a small part of the global car fleet but are growing rapidly



Sources: Bloomberg and Bank of Canada calculations

The adoption of EVs is expected to increase quickly over the coming decades. In its base-case projection, the International Energy Agency (IEA) projects that roughly 120 million electric vehicles will be on the road in 2030 (**Chart 2**)—or roughly 7 per cent of the global passenger vehicle fleet in that year (**Table 1**). EVs are predicted to become even more cost competitive through 2030, largely because of technological breakthroughs in producing batteries.[2] These cost reductions should lower the need for government subsidies, although government incentives will still play an important role over the medium-term.

Chart 2: The International Energy Agency expects 120 million electric vehicles by 2030



Source: International Energy Agency, *Global EV Outlook 2018*

However, considerable uncertainty is associated with future EV sales. Crucially, the outlook for EVs' penetration depends on the ambitiousness of government environmental policies in the future.[3] Currently, government subsidies pay for about a quarter of the cost of every new EV worldwide (IEA 2018b). While many governments have set high-reaching goals for EV adoption

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[1] In Canada, EV sales accounted for only 1 per cent of new car sales in 2017 and 0.2 per cent of Canada's fleet of passenger vehicles.

[2] Battery cost makes up roughly one-third of the total retail price of an EV.

[3] Another potential hurdle for rapid EV expansion, which we do not explore in this note, is the potential scarcity of cobalt, a key input in constructing batteries. Demand for cobalt is expected to increase 10- to 20-fold over the coming decade as EV construction ramps up. The amount of cobalt demanded by EV batteries in 2030 alone would exceed cobalt's current production capacity.

in the coming decades, the direction of environmental policies can change quickly (**Appendix 1** lists current key EV targets of several major economies). For example, the IEA forecasts that by 2030 there could be as many as 300 million EVs (19 per cent of the global fleet) under a more ambitious set of environmental policies, or as low as 57 million (4 per cent of the global fleet) under a more modest set of environmental policies (**Table 1**).

Table 1: Three scenarios for electronic vehicles (EVs) by 2030 from the International Energy Association (IEA)

	Millions of EVs by 2030	Share of global fleet (%)
Base-case scenario	120	7.4
Ambitious environmental policies	300	18.5
Modest environmental policies	57	3.5

Note: IEA's base-case scenario assumes already-announced and likely new environmental policies that are supportive of EV growth. In addition to assumptions in the base-case, the scenario of ambitious environmental policies further assumes greater policy support for building recharging infrastructure and improving battery capacity. The scenario of modest environmental policies only assumes environmental policies that are already implemented.
Sources: International Energy Agency, BP and Bank of Canada calculations

2. The switch to EVs lowers gasoline consumption

The transition to EVs is expected to decrease gasoline consumption for passenger cars. The reduction in this consumption related to EV adoption is currently small. However, as the number of EVs grows, the switch from internal combustion engines (ICEs) to EVs can have a material impact on how much gasoline is consumed. Following the approached outlined by Dale and Smith (2016), we use the following formula to calculate the reduction in gasoline consumption related to EV adoption:

Gasoline savings (mb/d) = (# of EVs) * (average daily distance travelled per vehicle)
*** (fuel efficiency of gasoline-fuelled cars being replaced)**

Note that the degree of gasoline displacement is sensitive to assumptions about technological advancement and global driving habits. In this discussion we assume the following:

- **Not all EVs generate the same gasoline savings.** Based on projections from the IEA, we assume that one-third of the EVs on the road are battery electric vehicles (BEVs) and two-thirds are plug-in hybrid electric vehicles (PHEVs). We further assume that PHEVs are fuelled equally by gasoline and electricity, so they consume on average half the gasoline of an ICE for the same distance driven. If we assumed BEVs made up a greater share of the EV fleet or that PHEVs had a lower need for gasoline, then the level of gasoline displacement would be larger.

- **ICE fuel efficiencies will continue to improve.** Based on projections from BP (British Petroleum), we assume that the fuel efficiency of the average ICE will improve between now and 2030 from around 8 litres to 5 litres per 100 kilometres driven. This represents an annual increase of close to 3 per cent through 2030, faster than the 1.5 per cent rise observed over the past decade (BP 2016). This assumption does not rest on further major technological breakthroughs, but instead on wider adoption of existing technologies in emerging-market economies. If we assumed a lower level of efficiency, then each EV would displace even more gasoline consumption.
- **Increases in driving habits will be modest.** We assume that the average kilometres driven per vehicle will increase by only 4 per cent through 2030. If we assumed a longer distance driven per vehicle, then the level of gasoline displacement by each EV would be larger.

Based on these assumptions, we calculate that for every 100 million EVs on the road in 2030, roughly 1 million barrels per day (mb/d) of gasoline consumption will be displaced. We summarize our key assumptions in **Table 2** and calculate what the difference in gasoline displacement would be at different levels of EV penetration. Under its base-case outlook, which puts 120 million EVs on the road in 2030, the IEA projects that the gasoline consumed by passenger vehicles will reach around 23 mb/d in 2030. We estimate that fuel consumption would have been 1.1 mb/d higher than this base-case scenario if there were no EVs on the road by 2030. Moreover, we estimate that this consumption could be as high as 23.7 mb/d and as low as 21.4 mb/d under the ambitious and modest policy scenarios, respectively.

Table 2: Key assumptions used to measure gasoline savings from electronic vehicles

	Current	2030 estimates
Percentage split between BEVs and PHEVs	45 / 55	33 / 66
Average distance travelled per vehicle per year (thousands of kilometres)	14.8	15.4
Average fuel consumption (litres per 100 kilometres)	8.5	5.2

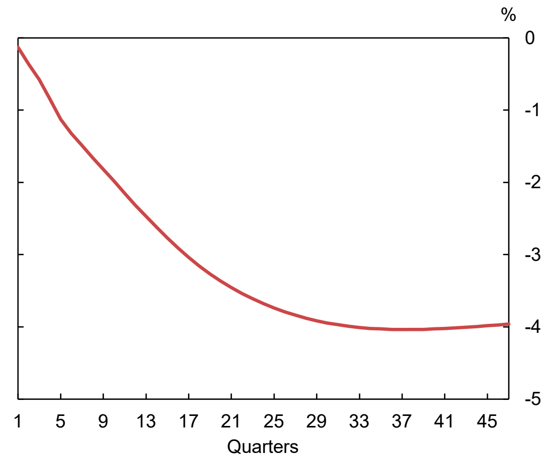
Note: Battery electric vehicles (BEVs) are powered exclusively by electricity. Plug-in hybrid electric vehicles (PHEVs) are powered by a combination of gasoline and electricity.

Sources: International Energy Agency, BP and Bank of Canada calculations

3. Increased numbers of EVs will lower oil prices, but the outlook for oil demand depends on the response of other industries

We quantify the impact on oil prices of gasoline savings related to EVs with the help of a structural vector autoregression (SVAR) model for the global oil market. The SVAR is based on oil production, consumption, the real price of oil and global gross domestic product (GDP) (Ellwanger 2019). Oil price movements can be decomposed into four identified structural shocks: oil supply shocks, oil-market-specific demand shocks, storage demand shocks and global economic growth shocks. We present the model's impulse responses to these shocks in **Appendix 2**. Within the framework of the SVAR, gasoline savings related to EVs can be implemented as an oil-market-specific demand shock. The switch to EVs represents an unanticipated change in the pattern of oil demand that is not driven by exogenous movements in global GDP growth.[4]

Chart 3 : An additional 100 million electric vehicles in 2030 would lower oil prices by 4 per cent



Note: Percentage decline in oil prices following a 1 million barrels per day shock to gasoline consumption
Source: Authors' calculations

Our analysis shows that an additional 100 million EVs on the road in 2030 would lower oil prices by about 4 per cent. We implement a series of oil-market-specific shocks that reduce gasoline consumption by a small and equal amount in each period, such that gasoline consumption from passenger vehicles would be one mb/d lower in 2030. The shock to oil prices builds gradually over the scenario sample, reaching a peak impact of around 4 per cent after five years (**Chart 3**).[5]

Table 3: Implications of electronic vehicle adoptions by 2030 for gasoline consumption and oil prices

	Electronic vehicle fleet (millions)	Vehicle gasoline consumption (millions of barrels per day)	Brent oil prices (real 2017 US dollars)
IEA's base-case scenario	120	23.1	$90
Ambitious policies	300	21.4	$85
Modest policies	57	23.7	$93

Note: The numbers shown for the International Energy Association's (IEA) base-case scenario are taken directly from IEA's *World Energy Outlook 2019*. The vehicle gasoline consumption and Brent oil prices shown under the ambitious policies and modest policies scenarios are based on the authors' estimations.

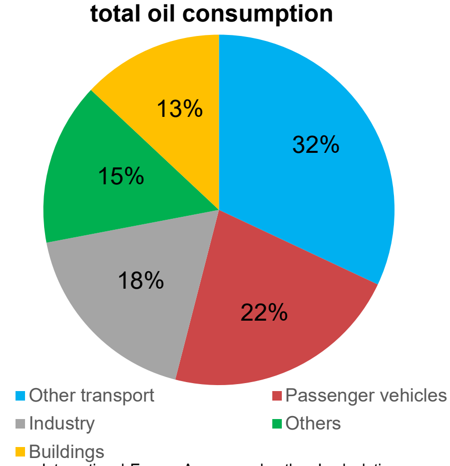
[4] If gasoline savings are anticipated, then inventory holdings would adjust right away. We would model this as a storage demand shock. We do not discuss this scenario since expectational shocks are difficult to calibrate in our modelling framework.
[5] In our scenario, the shock to oil prices builds gradually as more EVs are adopted. As shown in Appendix 2, an oil-market-specific shock that lowers gasoline consumption by one mb/d within a single period would have a peak impact on oil prices of around 10 per cent.

Relative to IEA's base-case forecast of US$90, oil prices in 2030 could move within the US$85 to US$93 range depending on the speed of EV adoption (**Table 3**). The IEA projects oil prices to be around $90 (real 2017 US dollars) in 2030 in its base-case scenario, which incorporates the assumption of 120 million EVs and around 23 mb/d of gasoline consumption from passenger vehicles (**Table 3**). Using the rule-of-thumb on EVs and oil prices discussed above, we can quantify risks to the IEA's base-case projection of oil prices based on different scenarios for EV adoption. Specifically, we find that oil prices may be $5 lower or $3 higher depending on whether environmental policies are more ambitious or more modest relative to the base-case.

This difference in projected oil prices due to assumptions on EV adoption appears small (at least relative to observed volatility in oil prices). But two important caveats must be considered:

- **The share of EVs in the global passenger vehicle fleet will remain modest through 2030.** Even under the most ambitious scenario we analyzed, EVs make up less than 20 per cent of the global fleet. This compares with 4 per cent if countries adopt only modest environmental policies.
- **While greater EV use reduces gasoline consumption, the impact on total oil consumption is more ambiguous.** Gasoline consumption by passenger vehicles makes up only 22 per cent of total oil consumption (**Chart 4**). How the EV shock affects total oil consumption, therefore, depends on how demand reacts to lower prices in the remaining oil-consuming industries. Based on the pattern of historical oil-market-specific demand shocks in our model, total oil consumption would turn negative at first. But it would eventually recover over the forecast as other industries increased their use of lower-priced oil.[6]

Chart 4: Passenger vehicles account for less than one-quarter of total oil consumption



Sources: International Energy Agency and authors' calculations

[6] In fact, the long-term effect on total oil consumption turns slightly positive in the very long run within the SVAR framework. This issue arises since there are no long-run restrictions imposed for the identification of this shock in the version of SVAR used. However, tougher environmental policies would be expected to reduce demand response to lower oil prices across all industries. Therefore, the negative impact from our model on prices and consumption may be too small. These effects are difficult to calibrate in our modelling framework, but they could be material.

4. Conclusion

The increased use of EVs is likely to affect the global oil market, but changes are expected to occur gradually. The IEA's base-case scenario assumes that 120 million EVs will be on the road by 2030, but the size of the EV fleet could range from 57 million to 300 million depending on the ambitiousness of environmental policies. Our analysis shows that, relative to IEA's base-case projection of US$90 per barrel, oil prices in 2030 could reasonably move within US$85 to US$93, given the range of reasonable scenarios for the size of the EV fleet. The reduction in oil prices related to the assumption of EV adoption is relatively modest, since EVs will account for less than 20 per cent of the global passenger vehicle fleet in 2030 even under the most optimistic scenario. Moreover, demand in other oil-consuming industries could react positively, mitigating the negative impact on oil consumption and oil prices brought about by the adoption of EVs.

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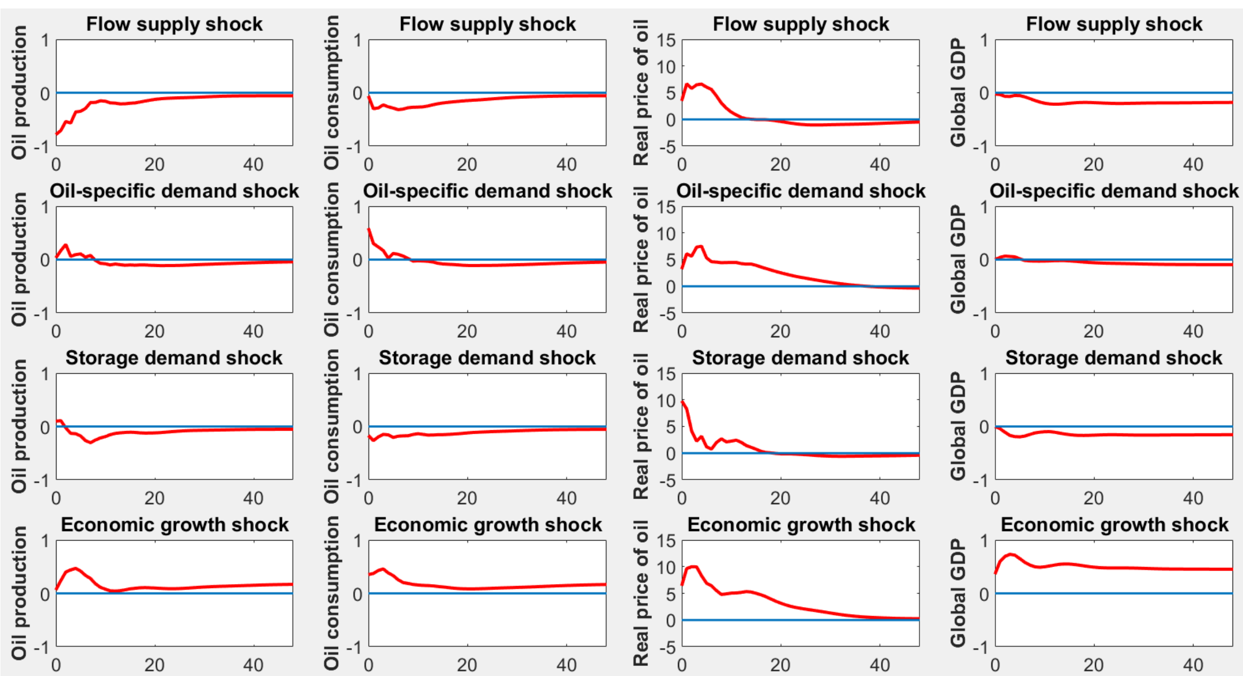
Appendix 1: Policies on electronic vehicles in key consumer markets

	2020–30 electronic vehicle (EV) targets by country
China	• New energy vehicle (NEV) mandate: 12% rebate on NEV sales by 2020 (NEV includes battery vehicles or plug-in hybrid vehicles.)
	• 5 million EVs by 2020, including 4.6 million light-duty vehicles
	• NEV sales share: 7–10% by 2020, 15–20% by 2025 and 40–50% by 2030
European Union	• Post-2020 proposed carbon dioxide (CO2) targets for cars and vans include benchmarks: 15% EV sales by 2025 and 30% by 2030
	• Proposed reduction in CO2 emissions in 2030 by 30% of 2021 level
India	• EV sales to reach 30% of total car sales by 2030
	• 100% of urban buses sold to be battery electric vehicles (BEV) starting in 2030
United States (selected states)	• 3.3 million EVs in eight states combined by 2025
	• Zero-emission vehicle (ZEV) credit mandate in 10 states: 22% rebate by 2025

Sources: International Energy Agency, *Global EV Outlook 2018*; and Bank of Canada

Appendix 2: Impulse responses to structural shocks



Note: The charts show impulse responses to a one-standard-deviation shock. All responses are measured in per cent. The horizontal axes denote quarters.
Source: Ellwanger (2019)