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DRIVING ELECTRIFICATION

A GLOBAL COMPARISON OF FISCAL INCENTIVE POLICY FOR ELECTRIC VEHICLES

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EXECUTIVE SUMMARY

Governments around the world—motivated by long-term targets for climate change mitigation and reduction of petroleum use—have set goals to increase electric vehicles' future market share. In support of these goals, some governments have enacted direct subsidies, fiscal incentives, and regulatory policy to help accelerate the movement of electric vehicles into the marketplace.

In the meantime, the number of electric vehicle models is increasing as early market adopters have begun to purchase these advanced-technology electric vehicles. The global sales of electric vehicles have about doubled in each of the past two years, from about 45,000 vehicles sold in 2011 to more than 200,000 in 2013. However, in the context of overall automobile sales, the consumer uptake of electric vehicles has been generally limited to less than 1% in nearly every major auto market.

This report is the first to evaluate the response to fiscal incentives in 2013 to incentivize the purchase of plug-in electric vehicles in major vehicle markets around the world. It offers a synthesis of wide-ranging sales data, national taxation policy information, and direct electric vehicle purchasing rebates to analyze the link between government policy and electric vehicle sales. It does so by focusing on two representative vehicles, the Renault Zoe battery-electric vehicle (BEV) and the Volvo V60 plug-in hybrid electric vehicle (PHEV).

This work identifies markets with varying market growth in electric vehicles and quantifies the taxation difference between electric vehicles and their conventional, non-electric counterparts. The report incorporates fuel and electricity prices to evaluate the equivalent total cost of ownership. Finally, the paper links the level of incentives to the level of electric vehicle market share and sales growth, seeking to draw conclusions about the impact of different incentive programs.

There are clear differences in the taxation benefits provided for electric vehicles and sales of electric vehicles across the major vehicle markets. Figure ES-1 summarizes the relationship between the equivalent per-vehicle fiscal incentive provided in each region (in percentage of vehicle base price, on the x-axis), and the respective passenger car market share of BEV and PHEV for 2012 and 2013 (y-axis).

For example, Norway's fiscal incentive of about 11,500 EUR per BEV (equivalent to about 55% of vehicle base price) is associated with a 6% market share for BEV in 2013, and a 90% market share increase from 2012 to 2013. Similarly, the fiscal incentive in the Netherlands of about 38,000 EUR for PHEV (equivalent to about 75% of vehicle base price) in 2013 is associated with a 5% market share for PHEV in 2013, and a 1,900% market share increase from 2012 to 2013.

These two examples indicate how national fiscal policy can offer a powerful mechanism to reduce the effective total cost of ownership and entice consumers to purchase electric vehicles.

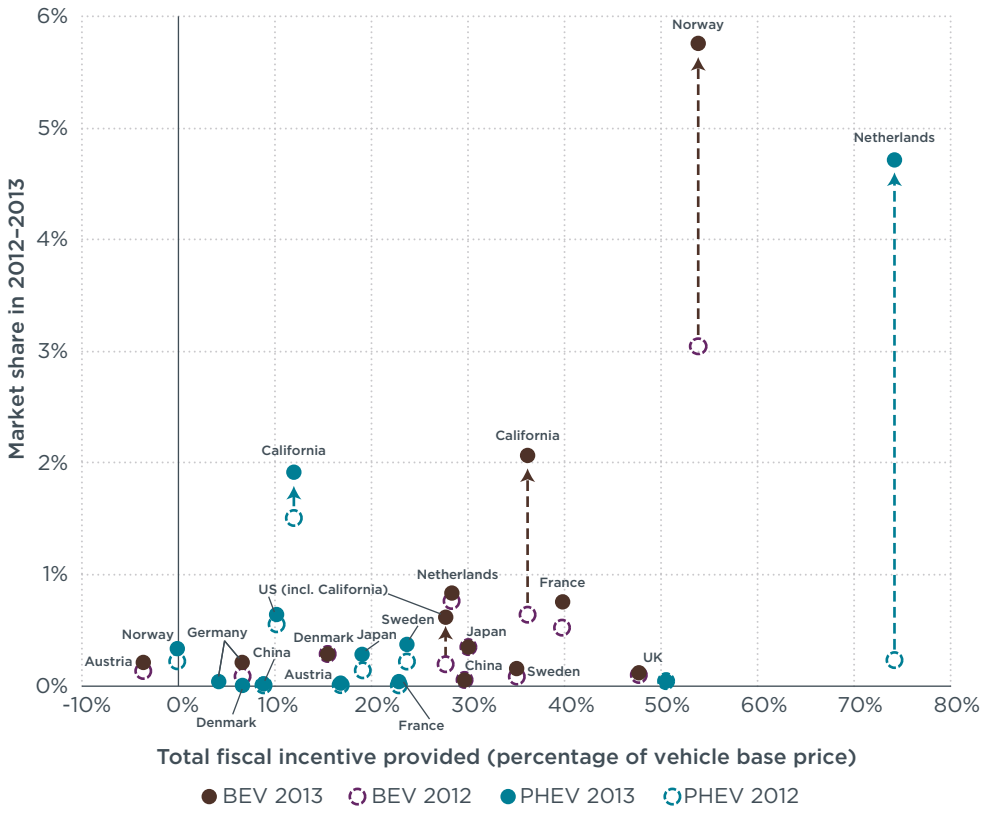

Figure ES-1. 2012 and 2013 market share vs. per-vehicle incentive for battery-electric (BEV) and plug-in hybrid electric PHEV (where applicable, only company car market incentives shown here)

The research findings indicate that fiscal incentives matter, but are clearly not the only factor that influences today's electric vehicle market growth. For example, despite a relatively high level of fiscal incentives, the current market share of EV in the United Kingdom (UK) was found to be low in comparison with other markets. Many confounding factors mean that a clear direct relationship remains elusive between national fiscal incentives and electric vehicles' early market growth across each of the major vehicle markets—as seen in the spread of the data and the lack of an obvious trend line in Figure ES-1 above. This indicates both the limitation of fiscal policy and also the limited understanding of all the underlying factors and other policies that could help drive and sustain the electric vehicle marketplace.

As a result, a more comprehensive study is needed of the full portfolio of policy actions taken to accelerate the early electric vehicle market—and their impact on the effective total cost of ownership. Such a study would investigate the importance of vehicle manufacturer policy (emission standards, electric vehicle requirements), infrastructure (residential equipment, public charging), electric utility actions (time of use charging), and other local policy (reduced rates for toll roads, preferential parking), along with the consumer fiscal policy evaluated here. A more comprehensive and rigorous assessment would help inform the development of a longer-term policy path that is less dependent upon large initial-year taxation incentives.

1 INTRODUCTION

We see quite a few electric vehicles coming on the market at the moment. New electric vehicle technology types keep emerging—from battery electric (Nissan Leaf, Renault Zoe) to blended plug-in hybrids (Toyota Prius plug-in) to range-extender plug-in-hybrids (Opel Ampera, Chevrolet Volt).[1] These technologies are increasingly being offered in more models, more vehicle classes, and more national markets.

Figure 1 illustrates the sales growth of these emerging technologies over the past several years. The figure shows how the global electric vehicle market has grown from less than 10,000 sold in 2009 to about 45,000 in 2011, more than 110,000 in 2012, and more than 210,000 in 2013.[2] In short, overall global sales approximately doubled in each of the past three years.

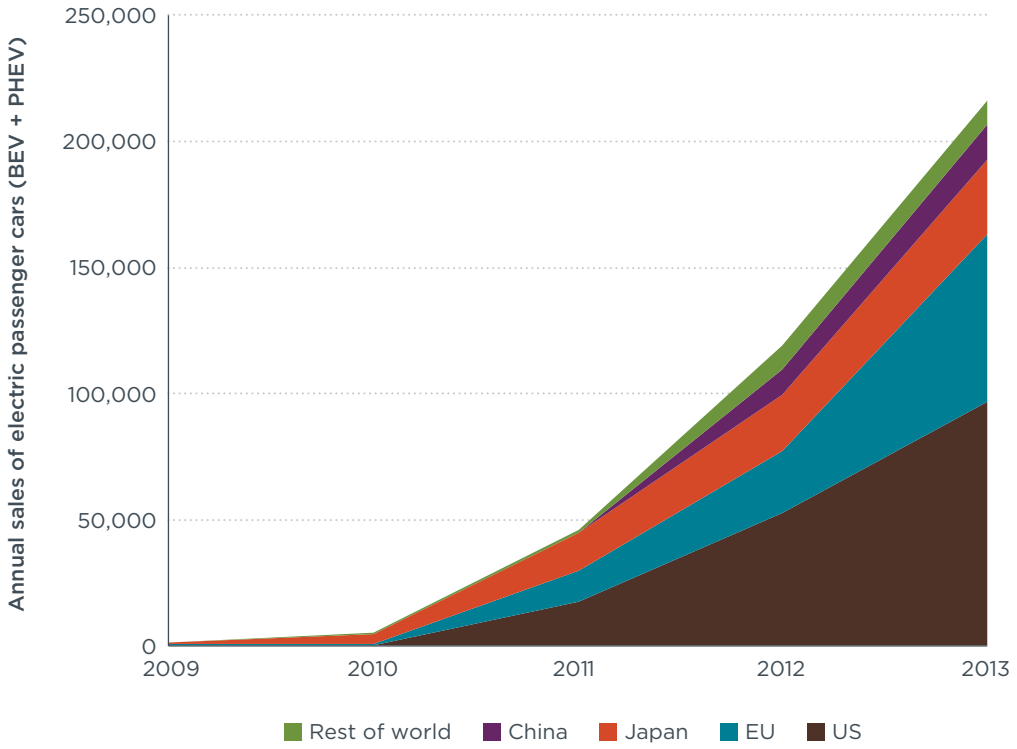

Figure 1. Global sales of electric vehicles (passenger cars), 2009–2013

Prominent government and research studies indicate that the long-term shift to an economy that is consistent with climate stabilization will require a vehicle fleet that is predominantly powered by electric drive in the 2040–2050 time frame (see Deetman et al, 2013; Williams et al 2011; Yang et al 2012). To be on a trajectory toward these long-term climate goals, many governments have established interim goals for electric vehicle (EV) market share in the relative near-term 2020–2025 time frame (see IEA, 2009; IEA, 2013). High-level electric policy goals and targets are being used in turn to guide and motivate various concrete policy actions to spur the market.

1 In this report, we focus on plug-in and battery-electric vehicles. Hybrids and fuel cell vehicles are not part of this analysis.

2 IEA, 2013, Cobb, 2014, EDTA, 2014, Loveday, 2013, EEA, 2012, Diem, 2012, EVObsession, 2014.

These policy mechanisms to accelerate the sales and use of electric vehicles are diverse and growing.

This paper analyzes the market shares of EVs and associated fiscal policies in a number of selected markets for the years 2012 and 2013. Similar studies have compared country-level fiscal EV incentives (see Crist, 2012). This work of comparative fiscal policy assessment seeks to consider the wealth of new data, the flurry of national policy activity, EV sales growth through 2013, and all major auto markets with significant EV sales. The report offers a novel synthesis of wide-ranging sales data, national fiscal policy information, and direct electric vehicle purchasing rebates. It identifies markets with particularly low or particularly high growth in full battery-electric (BEV) and plug-in hybrid electric (PHEV) vehicles. Evaluating two example vehicles—the Renault Zoe BEV and the Volvo V60 PHEV—against their conventional, non-EV counterparts illustrates the different levels of incentives in the selected markets. In addition, the report incorporates fuel and electricity prices to evaluate the equivalent total cost of ownership. Finally, the paper links the level of incentives to the level of growth and market volume, aiming at drawing conclusions about the effectiveness of different incentive programs.

The focus of this paper is on fiscal incentives and direct subsidies for EV customers. Although it analyzes the impact of direct consumer fiscal policy, we note that there are many other consumer-oriented policy actions simultaneously being utilized by various national and local governments.

These other actions include incentives for home and workplace charging equipment, public installation of charging equipment, preferential parking for EVs, preferential access to restricted highway occupancy vehicle lanes, and utility policies that promote EVs. Other important incentives are those directed more towards vehicle manufacturers, such as research and development (R&D) funding, vehicle efficiency and CO_2 standards, "super-credits," as well as direct EV mandates such as the California Zero Emission Vehicle program.[3]

As a result, we emphasize that this report is more narrowly focused on the direct impact from selected consumer-oriented fiscal policy, rather than an all-encompassing look at all the policy actions influencing the early electric-drive vehicle markets. We also emphasize that this report is focused primarily on major national-level policies. This is an important limitation, especially considering the increased importance of regional- and city-level policies and incentives, and the great concentration of EV sales in major urban metropolitan areas.[4]

3 See, for example, Cluzel et al., 2013 for a more comprehensive overview.

4 See http://www.wired.com/autopia/2013/08/five-cities-ev/; http://www.ibtimes.com/you-wont-believe-where-electric-car-demand-growing-fastest-us-hint-its-not-california-1557593; http://www.treehugger.com/cars/top-10-electric-car-states-are.html; http://blogs.wsj.com/chinarealtime/2013/11/27/china-hopes-cities-can-help-boost-electric-car-sales/; http://cleantechnica.com/2012/11/11/the-most-successful-electric-car-cities-infographic/; and https://www.iea.org/publications/freepublications/publication/name,31983,en.html.

2 ELECTRIC VEHICLE MARKETS IN 2012 AND 2013

Market shares of electric vehicles vary significantly across the world. As can be seen from Figure 2, Norway has the highest share of electric automobile sales (BEV and PHEV combined), with about 6% of all passenger cars sold in 2013. The Netherlands has the second-highest market share, with about 5.6%**.** The structures of the two markets are entirely different, though: While in Norway nearly all EVs sold are BEVs, in the Netherlands PHEVs clearly account for the majority of the market. The dynamics of the two markets are likewise significantly different: The market share of EVs in Norway doubled from 2012 to 2013, while in the Netherlands it quintupled between 2012 and 2013. The number of BEVs sold in the Netherlands remained about constant in this time frame, while the PHEV sales numbers exploded.

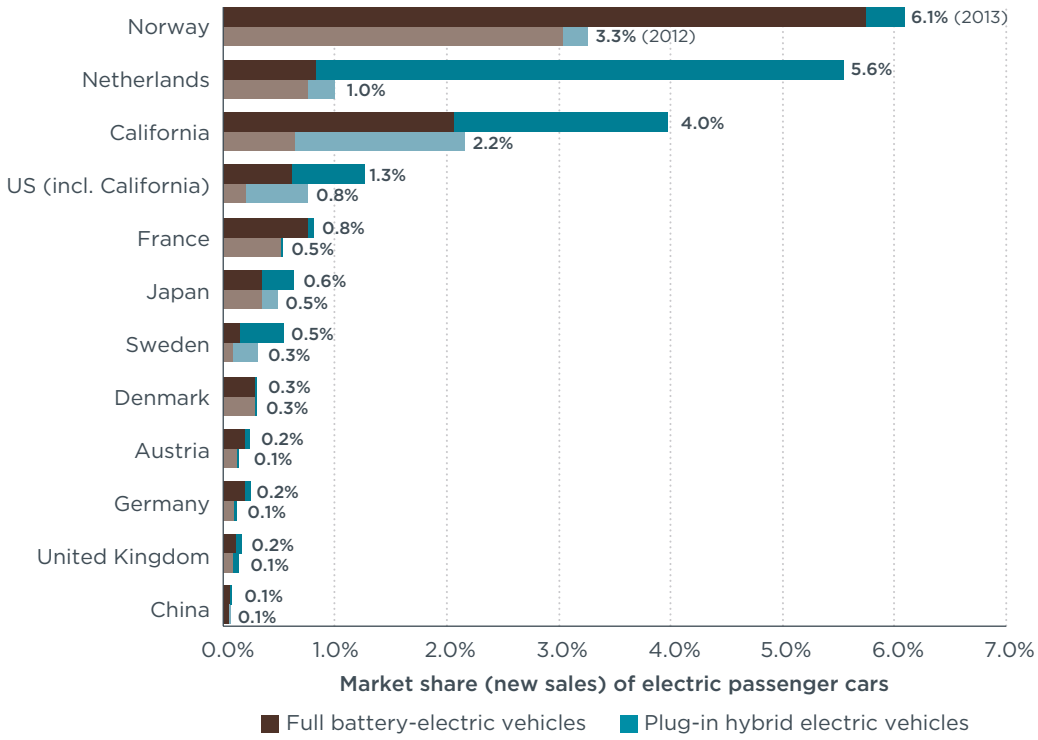

Figure 2. Market share of electric passenger cars for the years 2012 (lighter colors) and 2013 (darker colors), in comparison to total sales[5]

EVs' third-largest market share is in California, with about 4% of passenger car sales in 2013. About half of those were BEVs, while the other half were PHEVs. The EV passenger car[6] market share for the US as a whole was about 1.3% in 2013, a 70% increase over 2012, while in California the number of EVs increased by about 85% between 2012 and 2013.

All other markets examined for this paper show EV market shares of less than 1% in 2013. France had a market share of about 0.8% in 2013, almost twice as much as in 2012, with

5 Data sources: ACEA, 2014, CCFA, 2014, (CNCDA, 2014, Danske Bilimportører, 2014, DFT, 2013, EV sales, 2014, JAMA, 2014, KBA, 2014a, Mock, 2013b, SMMT, 2014, Statistik Austria, 2014, TØI, 2013, TRAFA, 2014, Wardsauto, 2013. China electric passenger car numbers are estimated based on CAAM, 2014 and CATARC, 2013.

6 Note that we use the "passenger car" category distinction for the US market throughout the report for comparisons across the various world passenger vehicle markets; this inherently excludes US "light trucks" including sport utility vehicles, minivans and vans, and pickup trucks that are not passenger cars by US regulatory categories.

virtually all EV sales being BEVs. Japan showed only a slight increase to about 0.6% in 2013. Sweden had a share of about 0.5%, again nearly twice the share of 2012, with 60% of vehicles being PHEVs. Germany and United Kingdom (UK) had comparably small market shares in 2013 (about 0.2%), but at the same time they (especially Germany) showed a strong increase from 2012 levels (about 105% increase), while Denmark and China had low market shares and at the same time relatively low growth rates of their EV markets.

Figure 3 illustrates the growth in sales from 2012 to 2013 in the selected countries. The growth is shown as the year-on-year percent change in market shares. Comparing the 2012–2013 growth rate for the selected markets, the Netherlands is clearly leading, with more than a 400% relative market share increase, from 1.0% to 5.6%. Germany is second, with a 105% market share increase. Norway, California, Sweden, the US, Austria, and France all show market share increases of 50–100%.

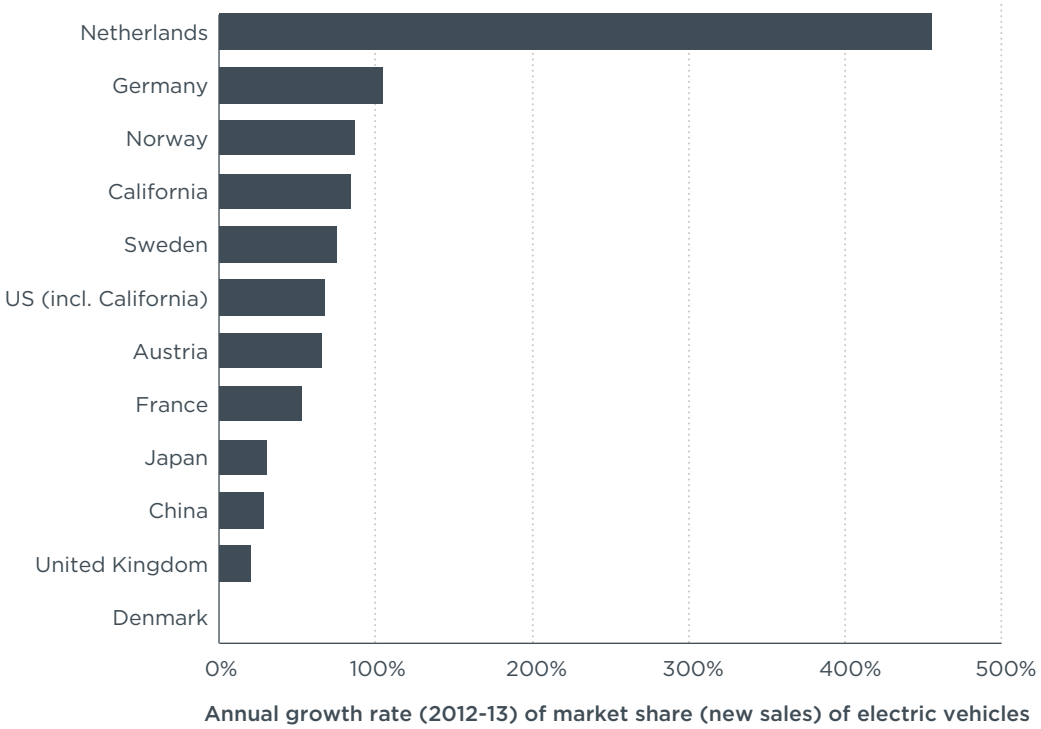

Figure 3. Year-on-year percent change, 2012–2013, in market share of electric passenger cars (BEV and PHEV)

Figure 4 and Figure 5 summarize the characteristics of the various markets, showing the 2012–2013 growth rate (y-axis) versus the 2013 market share (x-axis). Figure 4 shows this relationship for BEVs, while Figure 5 shows it for PHEVs. For BEVs, Norway is clearly leading, with close to 6% market share in 2013. At the same time, the US and California are showing a higher growth rate, although with a much lower market share as a starting point.

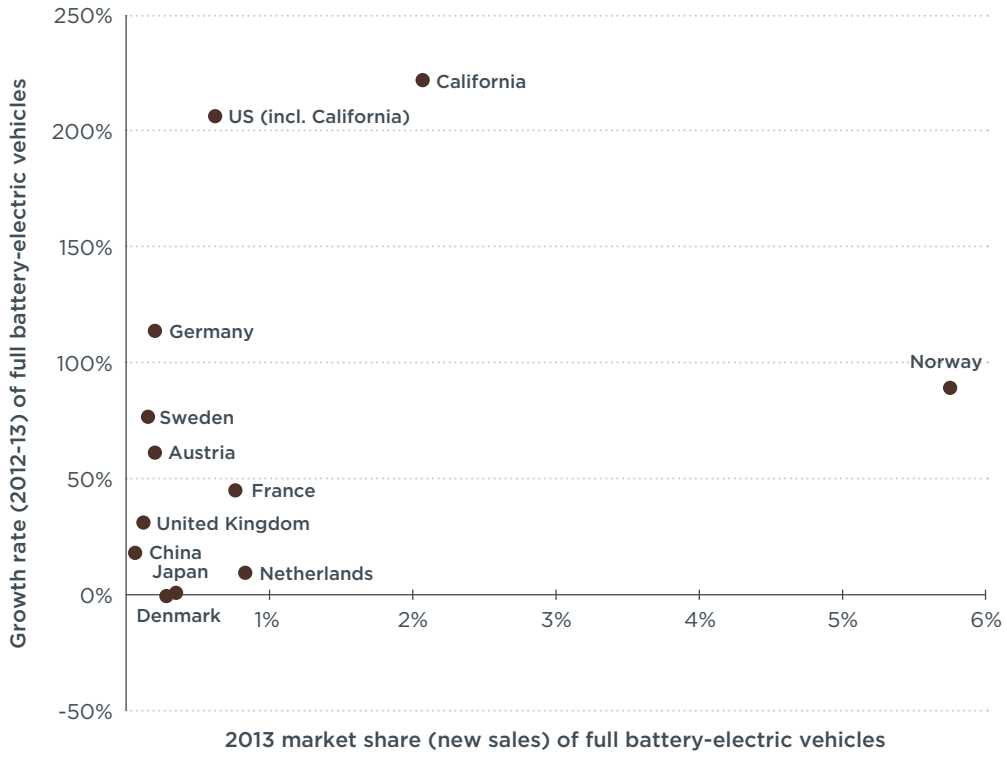

Figure 4. BEV 2012-13 market share growth rate vs. 2013 market share

For PHEVs, Netherlands is leading the field, with a market share of close to 5%, and a 1,900% growth rate for 2012–13. In comparison, other markets are far behind. Among them, California and the US are leading in terms of market share (around 1 to 2%), and Japan in terms of market growth (around 100% increase from 2012 to 2013).

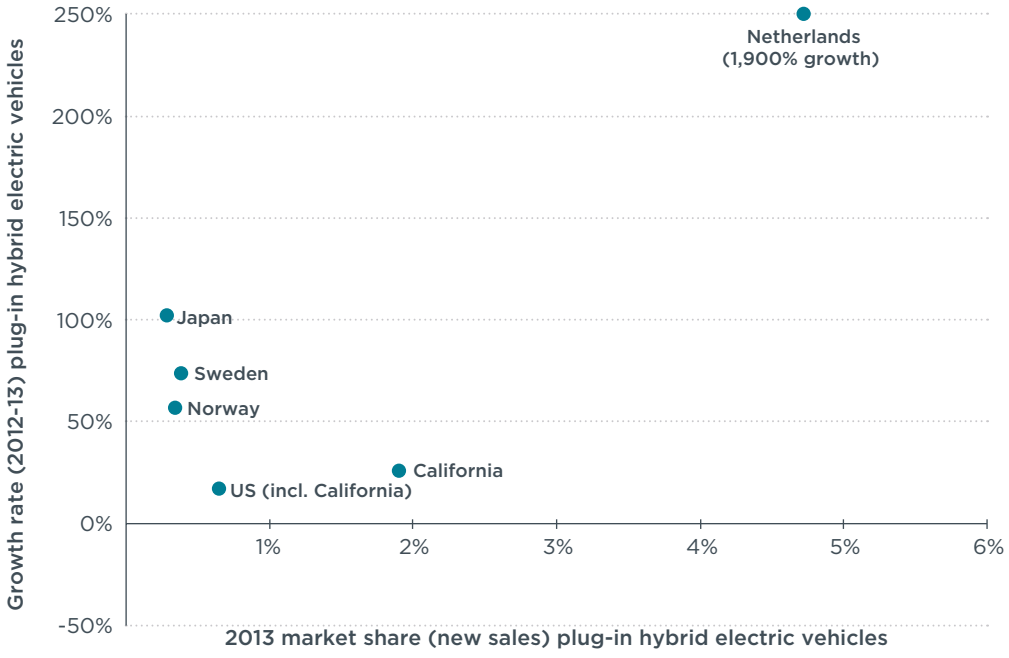

Figure 5. PHEV 2012–13 market share growth rate vs. 2013 market share[7]

7 Only those markets where the PHEV market share in 2012 was 0.1% or above are shown.

3 COMPARING INCENTIVES FOR ELECTRIC VEHICLES IN DIFFERENT MARKETS

There are numerous policy incentives intended to increase sales of EVs. For the following international comparison, we focus only on a few of these:

- **Direct subsidies** (defined here as a one-time bonus upon purchase of an EV)
- **Fiscal incentives** (defined here as a reduced purchase and/or annual tax for EVs)
- **Fuel cost savings** (incentive due to electricity prices being lower than fuel prices as a result of lower taxation and/or lower energy costs, as well as higher efficiency of EVs)

For a more complete list of instruments for incentivizing EV, for example for the case of Norway, see TØI, 2013 or, more generally, Cluzel et al., 2013. Some of these additional measures are expected to show a significant effect, but are difficult to quantify and compare. They are therefore excluded from this report's analysis. Note that all incentives examined in this paper are for the fiscal year 2013 (for a general overview of fiscal incentives, see German, 2010, and He and Bandivadekar, 2011).

To better quantify the incentives, two vehicles are selected as examples to be used in the comparison:

- **Renault Zoe** as a representative BEV, accounting for about 13% of all EV sales in Europe[8] in 2013 (EV sales, 2014). The Zoe is only available in an electric version. Its combustion engine counterpart is the Renault Clio, a vehicle from the small-car segment. The Clio is Europe's fourth most popular passenger car (Mock, 2013b).
- **Volvo V60** as a representative PHEV, accounting for about 11% of all EV sales in Europe in 2013 (EV sales, 2014). The Volvo V60 is available in a conventional diesel version, as well as in a diesel-PHEV version. The V60 belongs to the large vehicle segment.

Vehicle prices are adjusted so that they reflect approximately the same vehicle configuration in terms of optional equipment for both the EV and the gasoline/diesel version. In reality, vehicle prices will vary across countries, and the selected vehicle models might not even be available outside of Europe. However, in order to allow for a fair comparison of incentives around the world without having to worry about manufacturers' model and pricing strategies, the following underlying assumption was made for the comparison: The selected vehicle models are available in all the respective countries and vehicle prices (excluding taxes and subsidies) are always identical to the vehicle base price in Germany. Table 2 summarizes the vehicle characteristics for the comparison exercise.

8 The Renault Zoe is not available in vehicle markets such as the US. It is approximately equivalent in size to, for example, the Nissan Leaf.

Table 1. Characteristics of the vehicle models selected for the comparison[9]

Vehicle type	Renault Zoe	Renault Clio	Volvo V60	
	BEV	gasoline	diesel-PHEV	diesel
Engine power [kW]	65	66	206	158
Engine displacement [cm³]	n/a	898	2,400	2,400
Acceleration time 0-100 km/h [s]	13.5	13.0	6.1	7.7
Empty weight vehicle [kg]	1,428	1,009	1,955	1,821
Transmission type	automatic	manual	automatic	automatic
CO_2 emission [g/km NEDC]	0	99	48	169
Fuel consumption [l/100km NEDC]	0	4.3	1.8	6.4
Electricity consumption [kWh/100km]	14.6	n/a	21.7	n/a
Battery range [km]	210	n/a	50	n/a
Vehicle base price (Germany) excl. VAT [EUR]*	21,422	13,277	51,571	43,412

* Vehicle prices are adjusted for optional equipment and, for EV, include costs for battery (four-year rent cost if the battery is not purchased)

3.1 DIRECT SUBSIDIES

There are a number of countries that offer direct subsidies upon purchase of an EV:

- **France:** Within the context of the French Bonus/Malus vehicle taxation system, vehicles emitting less than 20 g/km of CO_2 receive a one-time bonus of 7,000 EUR (the amount of the incentive cannot exceed 30% of the vehicle purchase price including value-added tax, or VAT, and battery cost). For vehicles between 21 and 50 g/km, such as the Volvo V60 PHEV, the bonus is 5,000 EUR.
- **UK:** Since 2011, customers who purchase a new electric car (a BEV or PHEV emitting less than 75 g CO_2/km or a fuel cell vehicle) receive a one-time bonus of 25% of the car, up to a maximum of 5,000 GBP (about 5,800 EUR). In the case of the Renault Zoe and the Volvo V60, both vehicles receive the maximum amount.
- **Sweden:** Since 2012, cars with a CO_2 emission of 50 g/km and less receive a one-time "super green car premium" of 40,000 SEK (about 4,500 EUR). The program runs through 2014 and will be paid to a maximum of 5,000 cars.
- **US and California:** A federal subsidy program for EVs allows for a one-time bonus, depending on the battery capacity of the vehicle, of up to a maximum of 7,500 USD in form of tax credit. For the Renault Zoe BEV, the bonus would be 7,500 USD (about 5,400 EUR); for the Volvo V60 PHEV, it would be 5,400 USD (about 3,900 EUR). In California, there is another subsidy program at the state level, granting BEV purchasers another 2,500 USD (about 1,800 EUR) and PHEV 1,500 USD (about 1,100 EUR) in the form of a one-time bonus payment.

9 Data sources: ADAC, 2014, AMS, 2014, manufacturers' websites

» **Japan:** A government program has allowed for a one-time bonus for EVs and other qualified fuel-efficient vehicles since 2009. The program was extended to 2013 with adjustment, and provides a bonus based on the price difference between the EV and a comparable gasoline car.[10] The bonus is capped at 850,000 JPY (about 6,300 EUR). For the vehicles chosen as examples, the Renault Zoe would receive a bonus of about 4,600 EUR, while the Volvo V60 would receive a bonus of about 3,400 EUR.

» **China:** Since 2010, a national program provides a one-time bonus for EVs and fuel cell vehicles. The program was recently extended from 2013 to 2015, with some revisions. The bonus is between 35,000 and 60,000 RMB (about 4,200–7,200 EUR) for BEVs, depending on the battery range of the vehicle, and 35,000 RMB (about 4,200 EUR) for PHEVs with battery range no less than 50 km. The Renault Zoe would receive a bonus of about 6,000 EUR, while the Volvo V60 would receive a bonus of about 4,200 EUR.

These direct subsidies for EVs are relatively easy to quantify and to compare across different countries, as they usually are defined as a fixed amount that is paid if a certain set of pass/fail criteria is met. However, it would be wrong to only focus on these, as there are other measures for incentivizing EVs that may be more difficult to quantify and to compare, but could have a similar or even larger effect.

3.2 FISCAL INCENTIVES

Fiscal incentives for EVs are another important element of encouraging the purchase of these vehicles. There are four main categories of tax breaks (TØI, 2013)[11]:

» **VAT:** All markets for this comparison apply VAT when a vehicle is purchased. The range of the tax is between 5% (Japan) and 25% (Denmark, Norway, Sweden) and usually applies to the base price of the vehicle, excluding any purchase/registration tax. Norway is the only market examined here which excludes BEVs from VAT. The saving is about 4,500 EUR for the Renault Zoe. The VAT exemption does not apply to PHEVs. In all other markets, EVs end up paying more VAT than their conventional counterparts. This is because EVs usually have a higher base price and are therefore subject to a higher VAT, even after the bonus has been deducted from the base price of an EV (as in China and Japan). For example, in Germany the Renault Clio (base price 13,277 EUR) is subject to 2,523 EUR of VAT, while the Renault Zoe (base price 21,422 EUR) pays 4,070 EUR.

» **One-time purchase/registration tax:** Some markets examined here charge a purchase or registration tax in addition to the VAT, and provide a tax break to EVs. For example, in the Netherlands, registration tax depends on the level of CO_2 emission of a vehicle, with higher rates for diesel than for gasoline vehicles. Vehicles with less than 95 g/km (gasoline) or 88 g/km (diesel) are exempt from the registration tax. In the case of the Renault Zoe, the resulting benefit amounts to only 500 EUR, as the Renault Clio's emissions (99 g/km) are just slightly above the 95 g/km threshold. In the case of the Volvo V60, the resulting benefit is much higher, about 11,000 EUR. This is because the V60 non-hybrid version emits 169 g/km of CO_2 and is a diesel vehicle, so the tax rates applied are quite high. Other markets with a strong effect of registration tax are Denmark and Norway. In Denmark, registration tax is calculated based on vehicle price, safety equipment on board,

10 The price and specification of comparable gasoline car are published by the government agency. For details, see http://www.cev-pc.or.jp/hojo/cev_shikumi.html

11 Data on vehicle taxes for this paper are mostly based on ACEA, 2013 and national documents, such as NEP, 2009 or Regeringen, 2013.

and fuel consumption. BEVs are exempt from registration tax. For the Renault Zoe, the estimated saving is about 14,000 EUR. In the case of the Volvo V60, the estimated amount of registration tax for the diesel PHEV version is about 77,000 EUR, compared with about 94,000 EUR for the regular diesel version. In Norway, registration tax is based on vehicle weight, engine power, and CO_2 emission. BEVs are exempt from registration tax. The savings for the Renault Zoe are estimated to be around 4,100 EUR. For the Volvo V60, a registration tax of about 37,000 EUR applies to the PHEV version, compared with about 35,000 EUR for the regular diesel version.

- **Annual circulation tax:** Some markets charge an annual vehicle ownership tax, and in so doing provide a tax break for EVs. In Germany, for example, annual circulation tax is calculated based on CO_2 emissions and engine capacity of a vehicle. BEVs and PHEVs are exempt from circulation tax for a period of 10 years from the date of their first registration. However, the savings are relatively small: 20 EUR per year in the case of the Renault Zoe and about 170 EUR per year for the Volvo V60 PHEV. In the Netherlands, the effect is larger. The annual circulation tax is generally based on vehicle weight. However, until end of 2013 all cars emitting less than 111 g/km (gasoline) or 96 g/km (diesel) of CO_2 were exempt from the tax. The annual saving in the case of the Renault Zoe is estimated to be around 380 EUR, in the case of the V60 about 1,900 EUR. The thresholds for tax exemption have been adjusted from January 2014 on, so that only cars with no more than 50 g/km of CO_2 are still exempt from annual circulation tax. For all following calculations, savings from tax breaks for annual charges have been estimated for a time period of four years. This is to reflect the time horizon an average customer takes into account when estimating his total cost of ownership (TCO).
- **Company car tax:** Company cars are very popular in many European countries. For example, in Germany in 2012, only 38% of new passenger cars were registered by private owners, while 62% were registered as company cars (KBA, 2013). This also includes short-term registrations from car dealers, but still the market share of company cars is quite significant. This is especially true for EVs: In 2012, only 399 new BEVs were registered by private owners, compared with 2,617 new BEVs registered as company cars. The basic idea behind the company car system is as follows: Instead of paying a higher salary to its employee, the company offers to provide him/her a car and to pay all related charges, usually including fuel costs. The company can claim the costs for the vehicle and associated charges as business expenditures and is subject to a lower profit tax. The employee, on the other hand, has access to a vehicle that he/she can also use for private trips. In return, the employee has to pay a special company car tax to account for the monetary benefit of having free access to a vehicle. The Netherlands is a good example of the effect that such a system can have on the costs of driving an EV. In the Netherlands, generally 25% of the vehicle's price will be considered part of the driver's income and is subject to income tax.[12] In 2013, passenger cars with a CO_2 level of no more than 50 g/km were excluded from company tax. Cars emitting 51-95 g/km (gasoline) or 51-88 g/km (diesel) were only subject to a 14% taxable income benefit. The estimated benefits in the case of the Renault Zoe are about 1,100 EUR per year, and in the case of the Volvo V60 PHEV about 4,300 EUR per year, for a time period of five years.[13] From 2014 on, vehicles with 50 g/km CO_2 and less will no longer be fully exempt from company car taxation.

12 For company car tax calculations, we assume that the personal income tax rate is 40%. For example, in the case of the Netherlands, if the vehicle price is 30,000 EUR, and 25% (7,500 EUR) of that price is considered for company tax, then the additional income tax paid amounts to 3,000 EUR (7,500 EUR x 40%).

13 As noted above, for our calculations we only consider a total time period of four years.

3.3 FUEL COST SAVINGS

On a tank-to-wheel basis, EVs are more energy efficient than comparable combustion engines. Table 2 summarizes the efficiency indicators for the selected vehicles.

Table 2. Energy efficiency indicators of exemplary vehicles

Vehicle type	Renault Zoe	Renault Clio	Volvo V60	
	BEV	gasoline	diesel-PHEV	diesel
Fuel consumption [l/100km NEDC]		4.3		6.4
Fuel consumption [kWh/100km NEDC]		~39		~64
Electricity consumption [kWh/100km]	14.6*		~22†	

* According to NEDC procedure.
† For the Volvo V60 PHEV, estimates for driving only electrically and driving only in combustion engine mode were derived from car magazine tests (AMS, 2014) and weighted equally (50:50) for all further fuel cost savings calculations.

Fuel/electricity consumption of a vehicle needs to be multiplied by the price for fuel/electricity to obtain an estimate for annual spending on fuel/electricity. As can be seen in Table 3, fuel prices (here only shown for gasoline) and electricity prices vary significantly across markets. This is also reflected in the estimated fuel cost savings. Norway, for example, has relatively high gas prices but relatively low electricity tariffs, so the resulting cost savings from switching to an EV are larger than in other markets. In Germany, the price of gas is comparably low (for European standards), while household electricity prices are comparably high, hence the estimated savings are lower. In China, the price of electricity is significantly lower than that of gasoline, and therefore the percentage savings of switching to an EV are high—however, because gas prices are low compared to other markets, the absolute savings are at the lower end of the spectrum.

Table 3. Gasoline and electricity price differences across countries, and estimated fuel cost savings of the Renault Zoe vs. Renault Clio

	Gasoline price* [EUR/l]	Gasoline price [EUR/kWh]	Electricity price† [EUR/kWh]	Fuel cost savings‡ [EUR/4 years]
Norway	1.80	0.20	0.18	2,045
Netherlands	1,76	0.20	0.19	1,921
France	1.57	0.17	0.15	1,854
UK	1.68	0.19	0.18	1,847
Sweden	1.71	0.19	0.21	1,725
Austria	1.45	0.16	0.20	1,312
Germany	1.49	0.18	0.27	1,275
China	0.94	0.10	0.06	1,271
Denmark	1.70	0.19	0.30	1,188
Japan	1.12	0.12	0.19	815
California	0.69	0.08	0.11	521

* Sources: EC, 2013, EIA, 2013, BJCDR, 2012, http://www.californiagasprices.com/.
† Sources: EC, 2013. Where data available, electricity price for domestic consumers, band DC: 2,500 kWh-5,000 kWh per year.
‡ We assume an annual mileage of 10,000 km, and a time period of four years

Estimated fuel cost savings are taken into account as an incentive for EV for the following calculations. This is due to the fact that—from a tax authority's point of view—it could be justified to charge a higher tax on electricity used for vehicles than for electricity used in a household, in order to account for the higher efficiency of EV compared to their combustion engine counterparts, and the losses in fuel tax associated with this. As we are not seeing such a move to higher EV electricity taxation at the moment, this can be seen as a way of governments to incentivize the purchase and use of EV. Some governments, such as municipal administrations in Los Angeles and San Diego, even offer reduced rates for electric EVs charging during off-peak hours, though that is not taken into account for this study.

3.4 COMPARISON OF INCENTIVES ACROSS DIFFERENT MARKETS

Figure 6 illustrates how the calculations of TCO were carried out. Norway, France, and Germany were chosen for this illustrative chart to demonstrate three very different types of systems for taxing EVs from private purchase. TCO for this analysis is defined to include vehicle base price (assuming the same price for all markets), VAT, one-time subsidies upon purchase of a vehicle, one-time registration taxes, annual ownership taxes[14] (for a time period of four years), and fuel/electricity costs (four years).

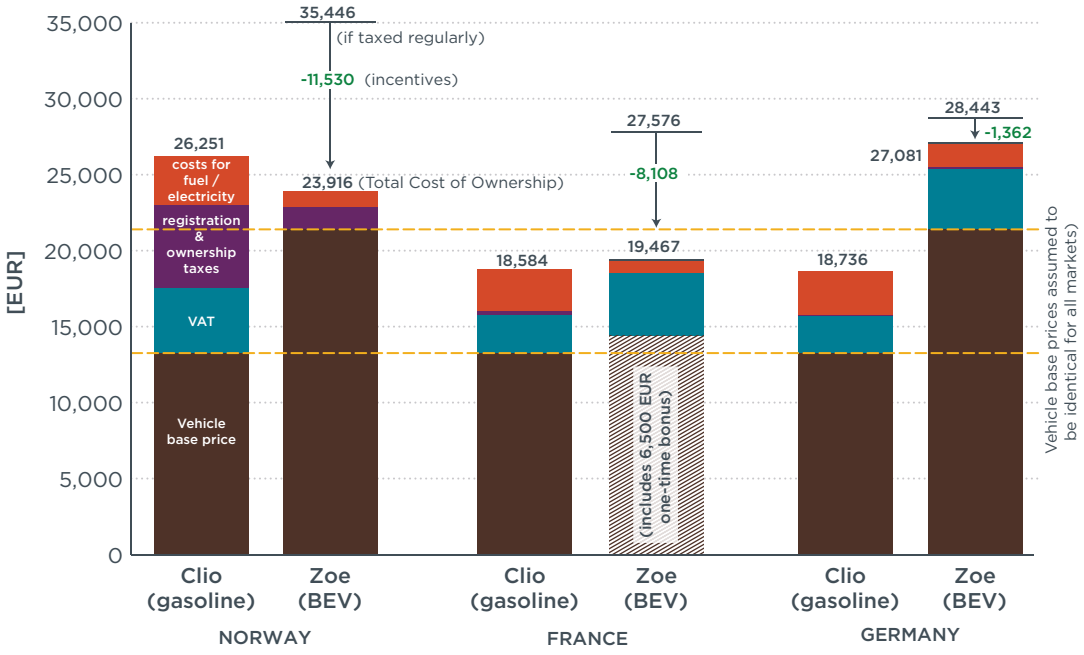

Figure 6. Evaluation of total cost of ownership for Norway, France, and Germany[15]

Vehicle prices are adjusted so that they reflect approximately the same vehicle configuration in terms of optional equipment for both the EV and gasoline-powered

14 The terms used for of one-time registration taxes and annual ownership taxes very between different countries.

15 TCO is defined here as vehicle purchase and registration costs, as well as ownership taxes and fuel/electricity costs for a time period of four years (10,000 km annual driving). All data estimates are for tax year 2013 private cars (no company cars).

versions. In reality, vehicle prices will vary between different countries, and the selected vehicle models might not even be available outside of Europe. However, in order to allow for a fair comparison of incentives around the world, without having to worry about manufacturers' model and pricing strategies, as mentioned earlier, it was assumed that the selected vehicle models are available in all the respective countries and that vehicle prices (excluding taxes and subsidies) are always identical to the vehicle base price in Germany. This is 13,277 EUR for the Clio and 21,422 EUR for the Zoe BEV.

In Norway, a relatively high amount of taxes is added for the Clio, while the Zoe BEV is partly exempt from these charges. For the Clio, a 25% VAT applies, plus a one-time registration fee of about 4,100 EUR. The Zoe is fully exempt from both these taxes. Annual ownership tax applies to both vehicles to the same extent. Electricity prices in Norway are on the lower end of the European spectrum, fuel prices on the higher end. As a result, estimated fuel cost savings for the Renault Zoe are 2,045 EUR. In sum, the BEV has more than 2,335 EUR lower TCO than the gasoline vehicle. The total incentives provided are estimated around 11,530 EUR.

France offers a one-time bonus for EVs. In the case of the Renault Zoe, this bonus is about 7,000 EUR. This more than compensates for the higher VAT, which applies to the BEV because of its higher base price. Furthermore, electricity prices are comparably low in France, resulting in high fuel cost savings when switching from the Renault Clio to the Zoe. Altogether, the estimated incentives provided for the BEV are 8,108 EUR. Taking into account all these incentives, the TCO of Renault Zoe is slightly higher than its combustion engine counterpart.

In Germany, a one-time registration tax of 29 EUR applies to both vehicles. Annual circulation tax is 18 EUR for the Renault Clio, amounting to 72 EUR for four years. The Renault Zoe BEV is exempt from this annual circulation tax. Fuel cost savings for the BEV are estimated to be 2,838 EUR. In total, TCO for the Clio and Zoe is 18,736 EUR vs. 27,081 EUR. Excluding fuel cost savings, taxes for the BEV are 1,476 EUR higher than for the gasoline counterpart. This is due to the fact that the base price of the BEV is higher, so in turn VAT is also higher. The exemption from the annual circulation tax is not sufficient to make up for the higher VAT. If the Renault Zoe were taxed "regularly," i.e. applying annual circulation tax and adjusting vehicle electricity taxation to account for higher efficiency, TCO for the Zoe would be 28,443 EUR. As a result, the total incentive for the BEV is estimated at 1,362 EUR, mainly as a result of fuel cost savings.

3.5 SUMMARY OF INCENTIVES

Figure 7 and Figure 8 summarize the calculation for the two selected vehicle pairs in this paper. Figure 7 illustrates the TCO calculations for the Renault Zoe and Renault Clio, both for the private car market (results for company cars are not shown here). The brown bars reflect the vehicle costs, including vehicle base price,[16] subsidies, VAT, and tax at registration and the following four years, while the blue bars show the fuel or electricity cost over a four-year period. The bubbles on the left-hand side illustrate the market share of BEVs/PHEVs in 2013 and furthermore indicate whether TCO for the EV version is lower (green) or higher (red) than for the combustion engine counterpart.

16 The resale value of vehicles after the assumed holding period of four years was not taken into account for this report.

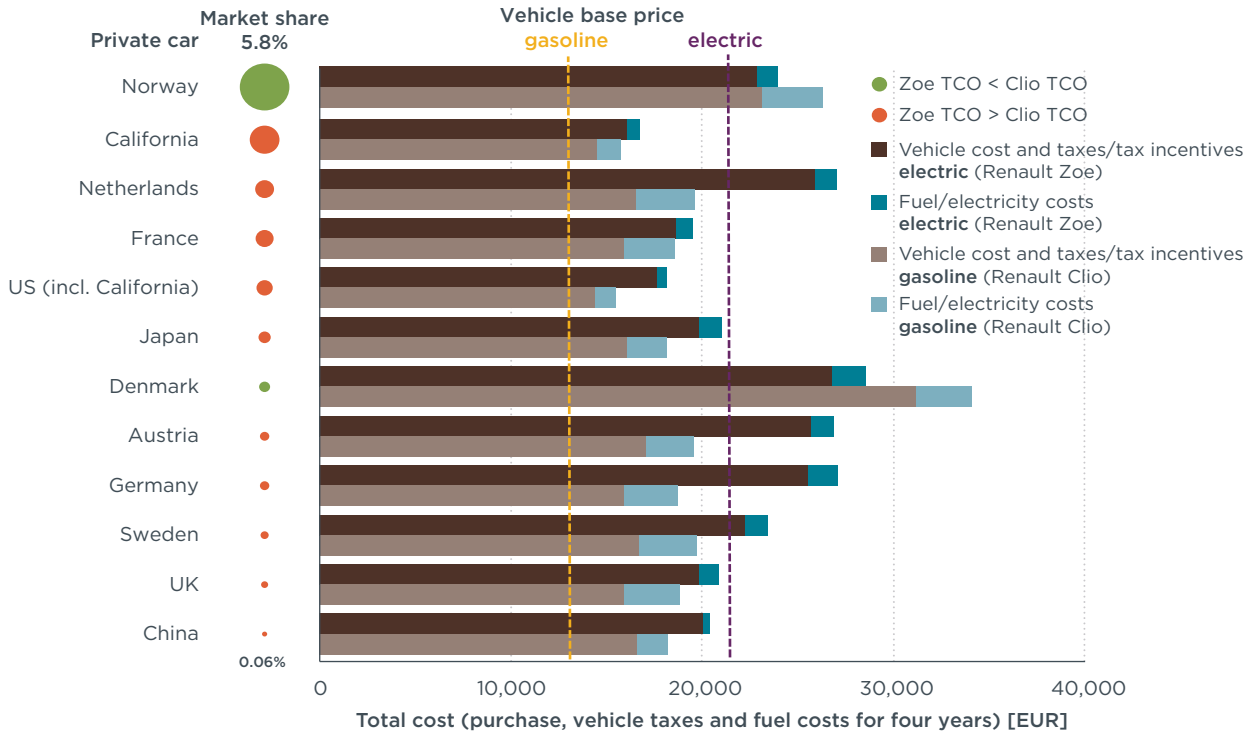

Figure 7. Summary of TCO calculations for Renault Clio vs. Renault Zoe (private car market)

Figure 8 illustrates the same TCO calculations, but for the Volvo V60 diesel-PHEV and the Volvo V60 diesel.

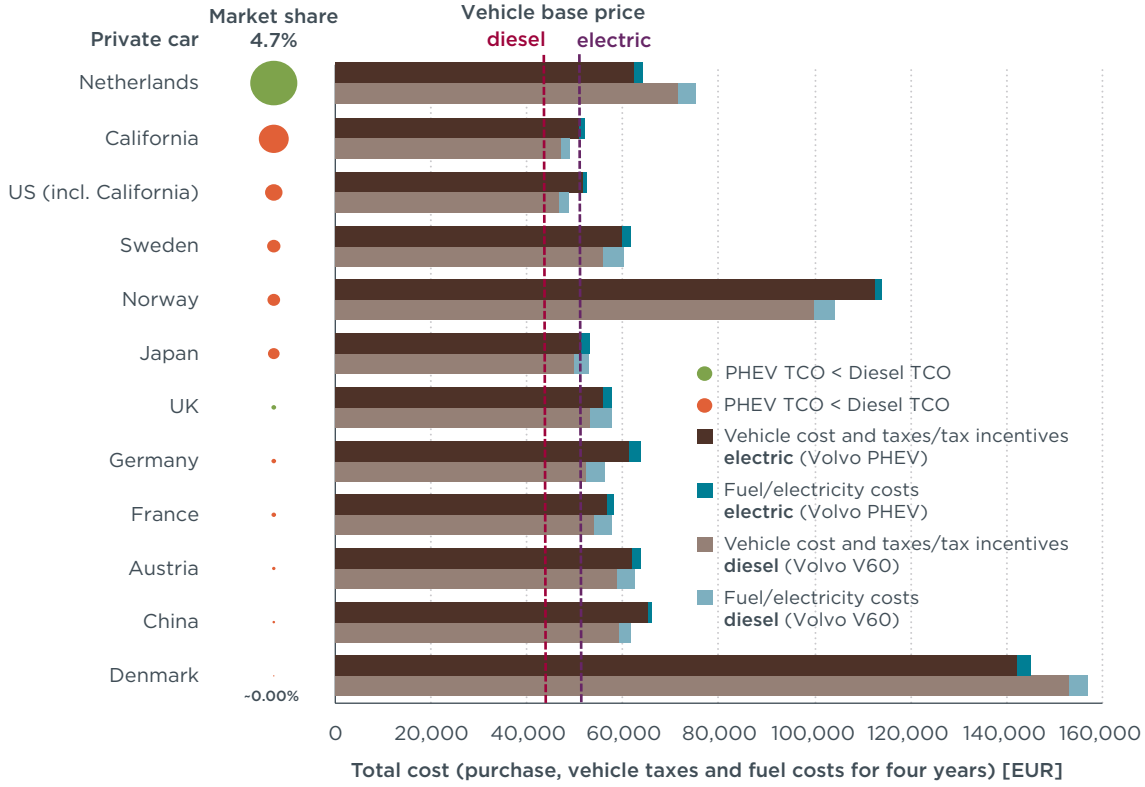

Figure 8. Summary of TCO calculations for Volvo V60 diesel vs. Volvo V60 PHEV (private car market)

Figure 9 and 10 summarize the estimated level of total incentives for the BEV (Renault Zoe) and PHEV (Volvo V60-diesel PHEV) when compared with the respective conventional vehicles (Renault Clio and Volvo V60 diesel).

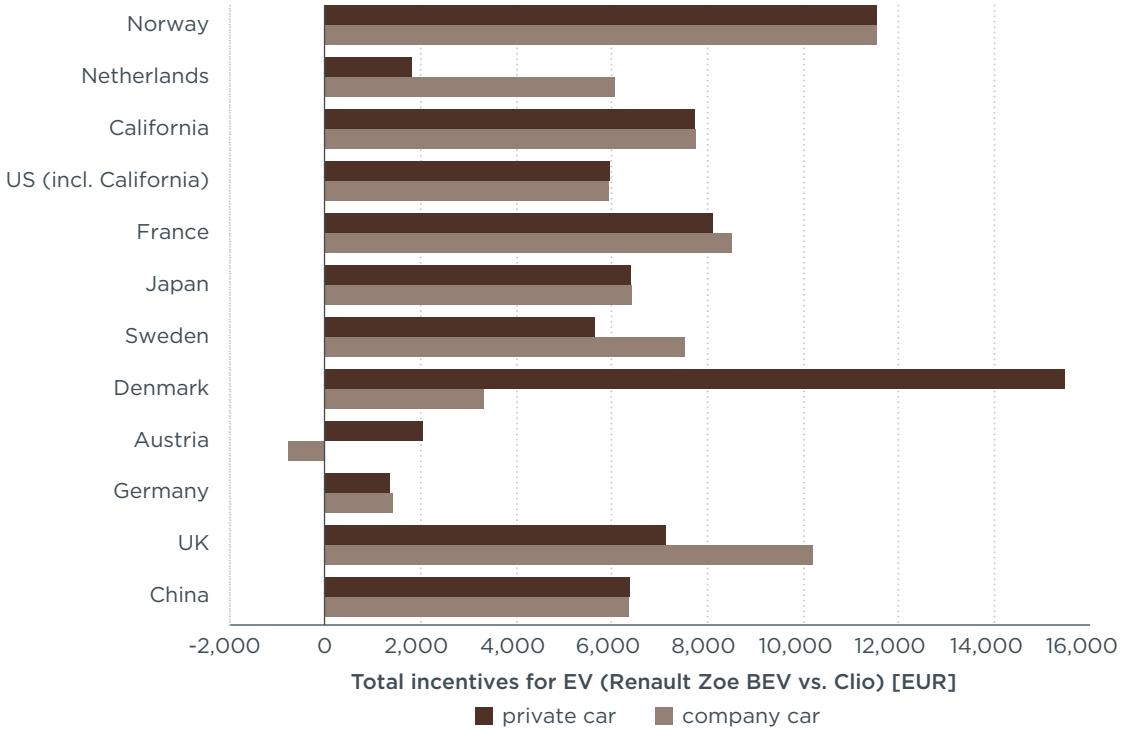

Figure 9. Estimated level of total incentives: Renault Zoe (BEV) vs. Renault Clio

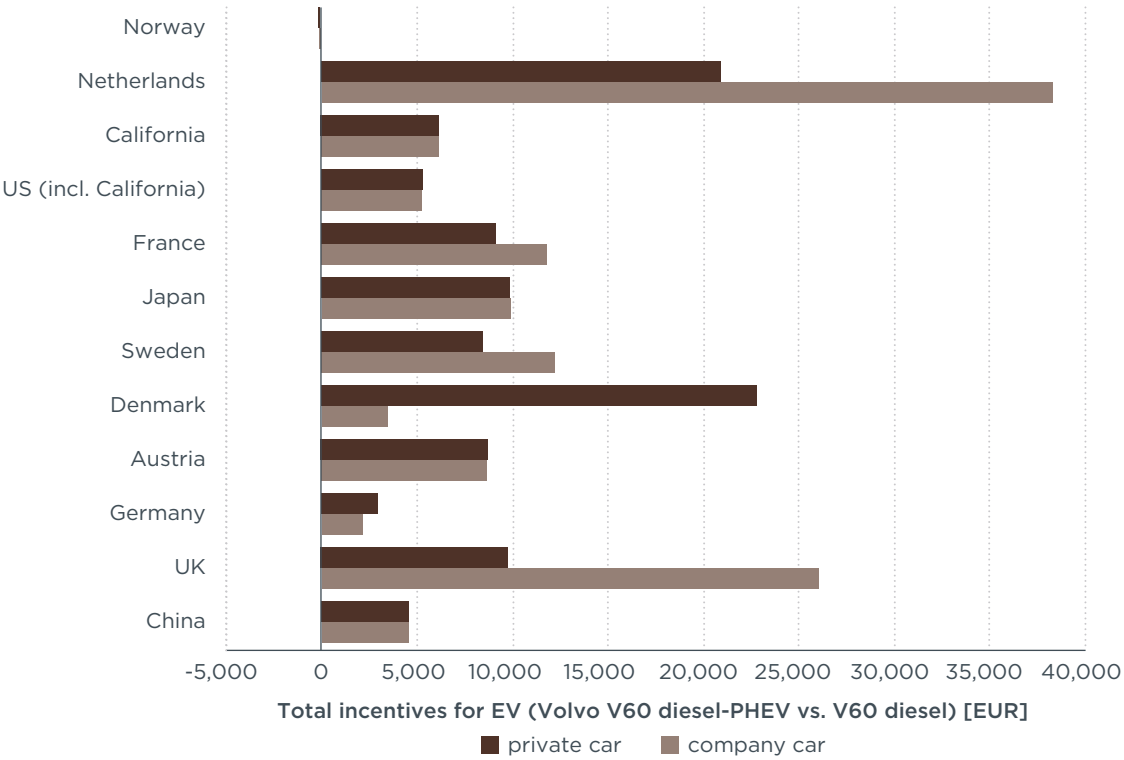

Figure 10. Estimated level of total incentives: Volvo V60 diesel-PHEV vs. Volvo V60 diesel

The following paragraphs list some key observations from these country-by-country comparisons.

Norway levies high taxes on vehicles with internal combustion engines. BEVs are largely exempt from these taxes, and also benefit from lower electricity costs. As a result, the TCO of the Renault Clio is significantly higher than the actual vehicle base price, while the TCO of the Zoe is only slightly above its base price. The total incentive provided for the BEV is about 11,500 EUR, the highest of all incentives among the markets analyzed (for private cars). For PHEVs, the situation is different, as they are not excluded from all taxes. There is still some incentive, but it averages out to close to zero; because of the high tax based on vehicle features (much higher engine power for the V60 PHEV) and high VAT based on vehicle price, the TCO of the V60 diesel-hybrid is higher than that of the V60 diesel. This is a sharp contrast to the incentives on the BEV side.

In the Netherlands, both BEVs and PHEVs are excluded from registration and ownership taxes. However, these taxes are largely based on the CO_2 emissions of a vehicle. As a result, the tax level for the Renault Clio is not too high anyway, and the tax break offered is not enough to compensate the higher vehicle price and higher VAT of this BEV. The situation is different for the Volvo V60, which has significantly higher CO_2 emissions, so the tax break for its PHEV version is much more significant. This effect is even larger for a company car than it is for a private car, as the tax is based on the CO_2 emission of the vehicle as well. In total, the incentives provided for the BEV amount to about 1,800 EUR for a private car and 6,100 EUR for a company car, and for the PHEV around 20,900 EUR (private) and 38,300 EUR (company).

As noted earlier, the US provides a one-time federal bonus upon purchase of an EV, and some states, such as California, provide additional state bonus and incentives to encourage EV purchases. The incentives would help to bring down the TCO of the Renault Zoe (similar to the Nissan Leaf) compared with its combustion-engine counterpart. For the Volvo V60 PHEV, the effect would be less due to the lower one-time bonus. In total, the incentives provided for the BEV amount to about 7,700 EUR (compared with about 5,900 EUR at the federal level) and about 6,100 EUR for the PHEV (compared with around 5,200 EUR at the federal level).

In France, a one-time bonus helps to reduce TCO for BEVs and, to a lesser extent, for PHEVs. As a result, the TCO for the Renault Zoe BEV is only a little higher than for the Clio. For the V60 PHEV, TCO is lower than for the diesel version if it is a company car. A private owner has to pay slightly higher TCO than if driving the diesel version. In total, France provides incentives of around 8,100 EUR (private) or 8,500 EUR (company) for the BEV, and about 9,100 (private) or 11,800 EUR (company) for the PHEV.

Japan exempts BEVs and PHEVs from acquisition tax and annual tonnage tax and reduces the annual automobile tax for both. Along with the low VAT tax and the one-time bonus provided for EVs, the incentives reduce the TCO of the Renault Zoe to only slightly above its base price, while the TCO of the Clio is much higher than its base price. The tax break is more effective for the PHEV because the three taxes are based on vehicle price, weight, and displacement, respectively, which are all higher for the Volvo V60. Thus the TCO of the Volvo V60 PHEV is the same as its diesel version. In total, Japan provides incentives of around 6,400 EUR for the BEV and around 9,900 EUR for the PHEV.

In Sweden, EVs receive a one-time bonus and are exempt from annual road tax, which is based on CO_2 emission. Because of high VAT, the incentives are not high enough to compensate the higher base price of BEVs. It is same for the PHEV, but the TCO of V60 PHEV is lower than its diesel version if it is a company car. In sum, Sweden provides about 5,600 EUR (private) or 7,500 EUR (company) for the BEV, and about 8,400 EUR (private) or 12,200 EUR (company) for the PHEV.

In Denmark, there is a very high registration tax, which is mainly based on vehicle price. EVs are exempt from registration tax, which explains why the TCO of the Renault Zoe is lower than that of the Clio. For the Volvo V60 PHEV this effect is even stronger, given the high purchase price of that vehicle. Registration tax is much lower for company cars than for private cars. The tax break for EVs is therefore no longer sufficient for compensating the higher vehicle purchase price and VAT, and so TCO for company cars is higher for the Zoe BEV while the TCO of the V60 PHEV is only a little lower than for its combustion engine counterpart. Overall incentives provided in Denmark are about 15,500 EUR (private) or 3,300 EUR (company) for the BEV, and about 22,800 EUR (private) or 3,400 EUR (company) for the PHEV.

In Austria, both BEVs and PHEVs are excluded from registration and ownership taxes. But the registration tax is largely based on fuel consumption. Thus the TCO of the Renault Zoe BEV is still significantly higher than that of the Clio, while the TCO of the V60 PHEV is only slightly higher than its diesel counterpart. The overall TCO savings is 2,000 EUR for private BEVs, whereas for company car BEVs in fact a -700 EUR disincentive applies. For the PHEV, the overall incentives are about 9,000 EUR (private and company).

In Germany, the higher price of the BEV and PHEV versions results in higher VAT and therefore actually a disincentive for the purchase of an EV. This is balanced by fuel cost savings, however, so that as a result TCO savings amount to about 1,400 EUR (private and company) for the BEV. Total incentives for the BEV are larger for company cars than for private cars because of a recently introduced regulation that takes into account battery capacity when calculating company car taxes and provides some credit for vehicles with higher battery capacity. For the PHEV, this effect is less prominent, resulting in higher TCO savings for private PHEVs (about 2,000 EUR) than for company PHEVs (about 2,800 EUR).

In the UK, most relevant influencing factors are a one-time bonus (about 5,800 EUR) upon purchase of an EV and a company car tax that is heavily based on vehicle CO_2 emissions. For private BEVs, the one-time bonus and fuel cost savings are enough to overcompensate for a higher VAT for the BEV if it is a company car. For a company car BEV, the effect is even stronger, resulting in significantly lower TCO for the BEV than for its gasoline counterpart. The total incentive provided for the BEV is about 7,100 EUR (private) and about 10,200 EUR (company). For the Volvo V60 PHEV, the effect of the CO_2-based company car tax is much stronger, resulting in a total incentive of about 26,000 EUR compared with about 9,800 EUR for the private PHEV.

China provides a one-time bonus for BEVs based on battery range, as well as for PHEVs to a lesser extent. Similar to the US, some provinces or cities (e.g., Beijing, Shanghai, and Guangdong) provide additional bonuses that may double the amount provided at the national level. However, the regional incentives are not taken into account in this paper. Even though the tax exemption from the “vehicles and vessels”

annual tax for EVs is not as significant as in many EU markets, the TCO of the Renault Zoe BEV significantly decreased, though it is still higher than that of the Clio. Similarly, because the other taxes are partially based on vehicle price, the incentives are not high enough to close the price gap between the PHEV and its conventional counterpart. Thus the TCO of the V60 PHEV is slightly higher than that of its diesel version. The overall incentives for the BEV are significant compared with other countries (about 6,400 EUR), while the incentives for the PHEV are not as high as in most of other markets (about 4,500 EUR).

4 FINDINGS ON INCENTIVES AND MARKET DYNAMICS

Having analyzed market shares and market share developments over time on one hand, and the level of incentives for EVs on the other hand, the following section aims at bringing both aspects together. Figures 11 through 14 illustrate the dynamics of EV market share from 2012 to 2013, the size of the BEV/PHEV market in 2013, and the total EV incentives in selected markets.

Figure 11 provides a view on the level of incentives, market growth, and market share for the BEV. Looking at company cars, the data points seem to suggest that a higher level of incentives indeed results in a higher market growth rate. According to the data, Norway is leading in terms of BEV incentives, and at the same time shows the strongest market size. The U.S. and California also show a high incentive, and at the same time the highest market growth rate observed. The UK, France, Sweden, the Netherlands, Japan, and China are located more in the middle, with incentives of around 6,100 to 10,200 EUR, and with medium-size/medium-growth BEV markets. Denmark ranges more towards the lower end of the incentive spectrum, around 3,300 EUR, and shows very little market growth. Exceptions to the general trend are Germany and Austria—both relatively small BEV markets at the moment, but with strong growth rates, despite their comparably low incentives for BEVs. For private car BEVs, the picture looks similar, but generally with lower incentive levels. An exception is Denmark, with a higher level of incentives for BEV if purchased as private cars, but with very little growth.

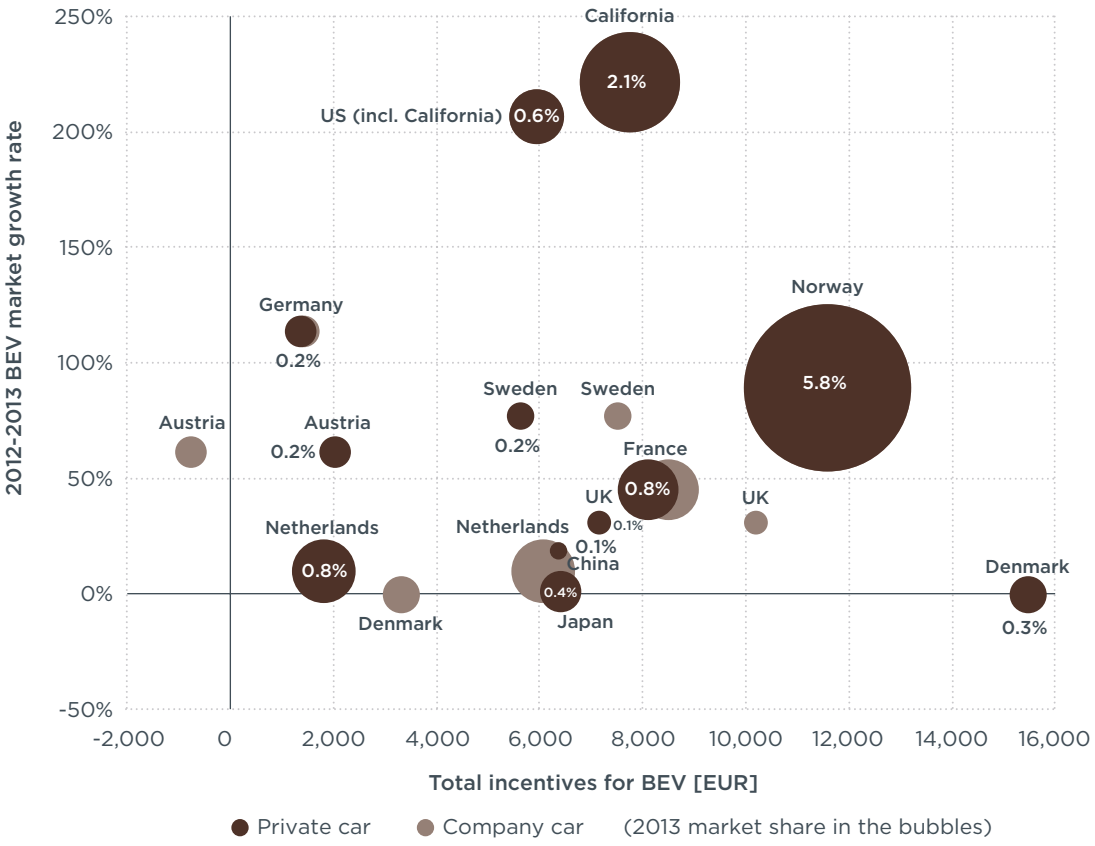

Figure 11. Market growth rate vs. per-vehicle incentive for BEV (Renault Zoe), private and company cars, 2012–2013

For PHEVs, the Netherlands provides an incentive that is substantially higher (about 38,000 EUR for company cars and about 21,000 EUR for private cars) than in any of the other markets. It also has the largest PHEV market and the largest market growth rate (Figure 12 and 13). The only other markets with a PHEV market share higher than 0.1% in 2013 are Norway, Sweden, Japan, the U.S. and California. All of these markets, except Norway, offer a relatively similar level of incentive for the analyzed V60 PHEV, ranging from about 6,100 EUR to 12,200 EUR for company cars and 6,100 EUR to 10,000 EUR for private cars. Norway, Sweden and Japan show similar growth rates for PHEVs, of about 60% to 100%.

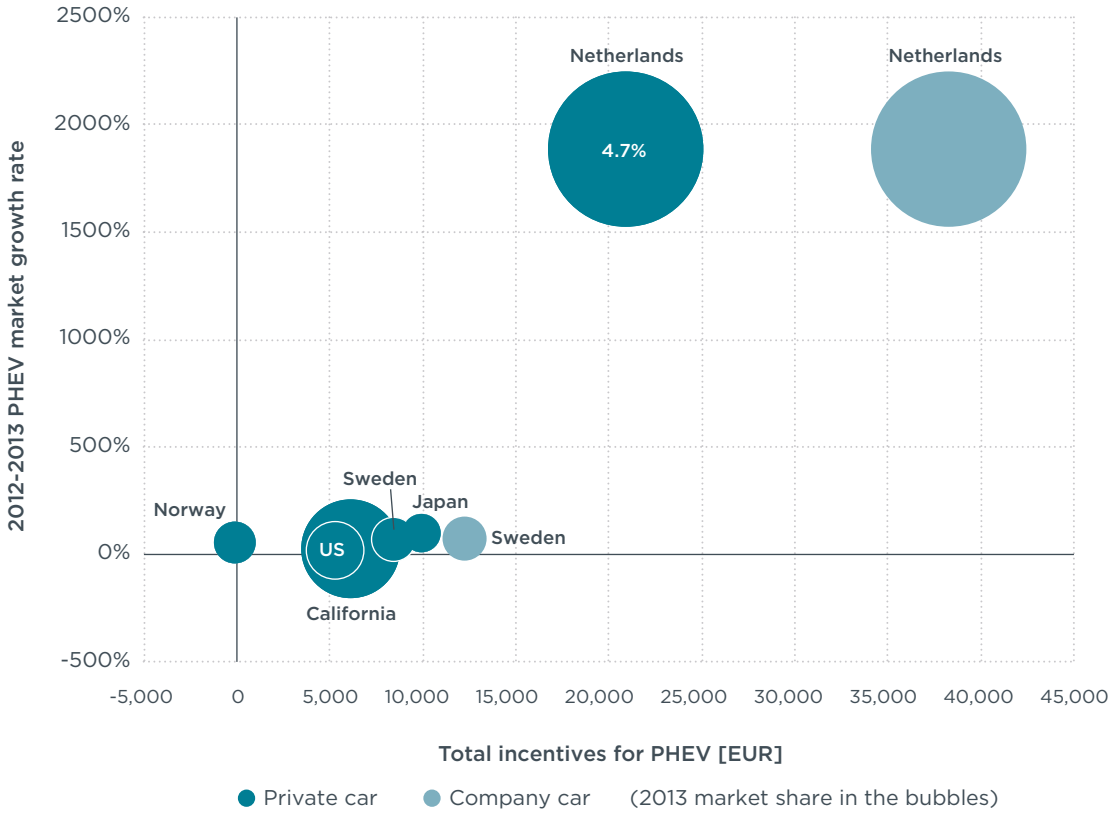

Figure 12. Market growth rate vs. per-vehicle incentive for PHEV (Volvo V60), private and company cars, 2012–2013[17]

17 Only those markets with a 2013 market share of PHEV higher than 0.1% are shown in this figure, as for markets with a lower market share, annual growth rates are not expected to be meaningful.

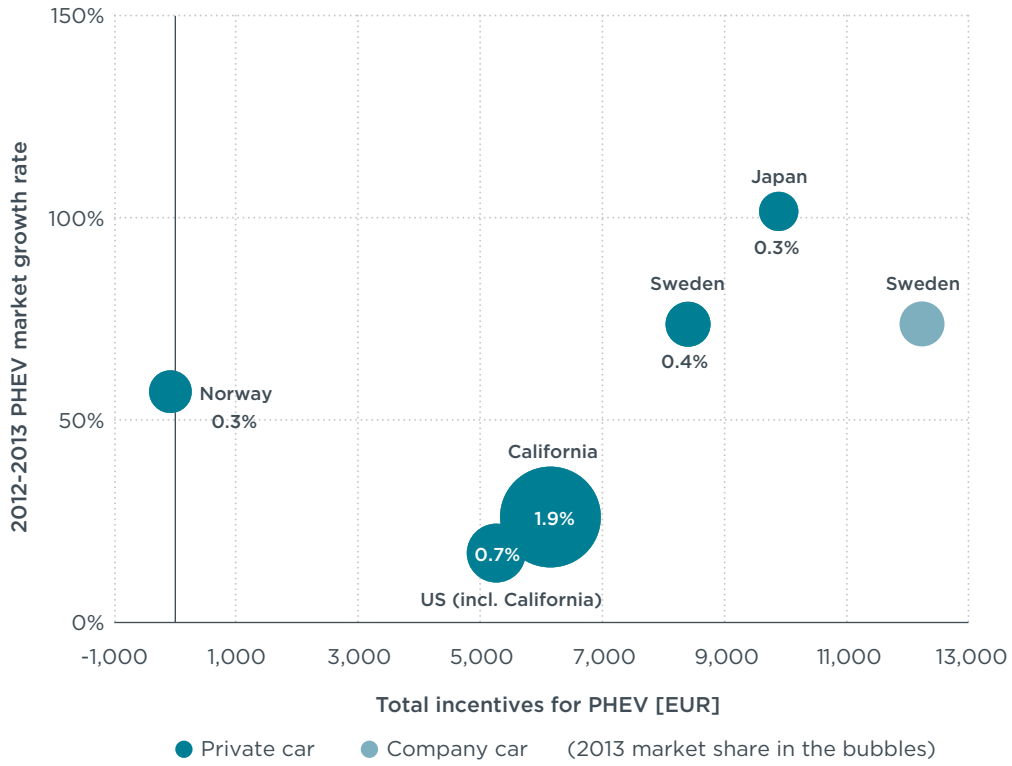

Figure 13. Market growth rate vs. per-vehicle incentive (without the Netherlands) for PHEV (Volvo V60), private and company cars, 2012–2013

Figure 14 combines BEVs and PHEVs in one chart, showing the total value of fiscal incentives per vehicle (calculated for the Renault Zoe BEV and the Volvo V60 PHEV) provided in 2013 on the x-axis and the respective BEV/PHEV new-vehicle market share per market in 2012 and 2013. For those markets where applicable, the fiscal incentive level shown is the one for company cars. Also, to allow for plotting the results for both example vehicles (BEV and PHEV) in one chart, the level of fiscal incentives provided was normalized as a percentage of vehicle base price. The relationship between the level of incentives provided and EV market share/market growth is consistent with the observations from Figures 11 to 13, with the Netherlands, Norway, and California having the highest market shares and growth rates.

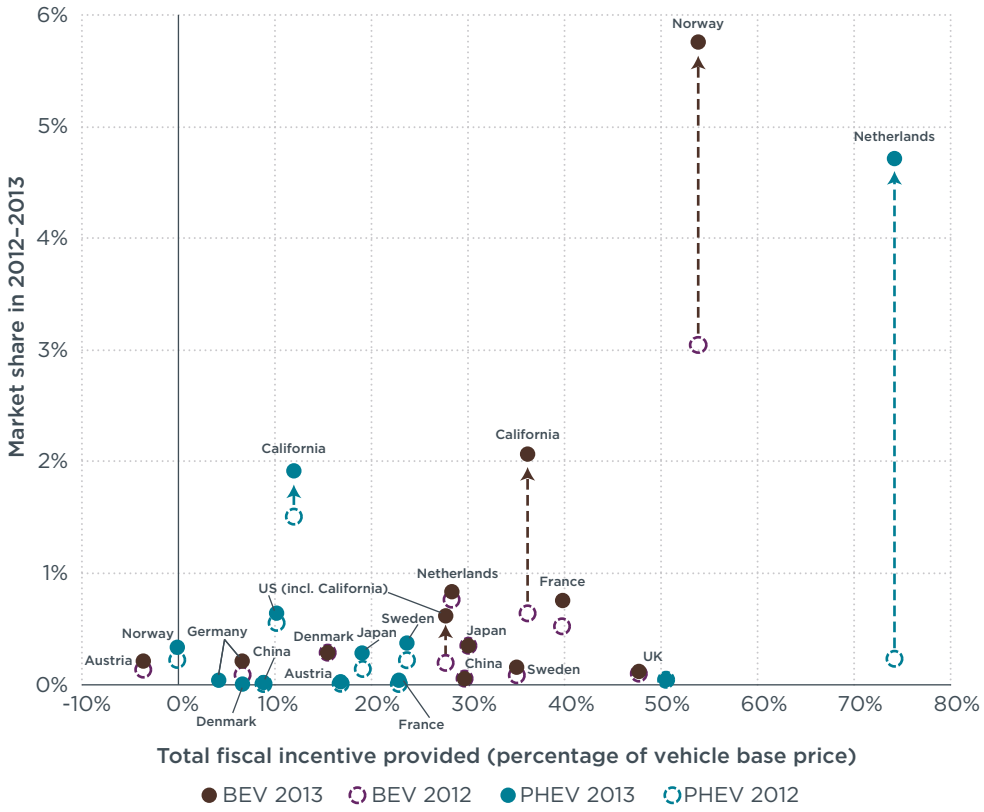

Figure 14. EV market share vs. per-vehicle incentive provided for BEV (Renault Zoe) and PHEV (Volvo V60) (where applicable, only company car market incentives shown here), 2012–2013

5 CONCLUSIONS

Based on the data collected and analysis in this paper, it is obvious that there are significant differences between EV markets and the associated fiscal policy. We sought to make some sense of these marked differences across the emerging EV markets, especially in the context of the direct EV subsidy and taxation incentives provided to EV consumers across the automobile markets. From this analysis, we draw two overarching conclusions.

Conclusion 1: National fiscal policy is a powerful mechanism to reduce the effective total cost of ownership and entice vehicle consumers to purchase electric vehicles.

There are substantial differences in terms of the absolute market share, differences in the growth rate, and differences in the type of EVs predominantly sold (BEVs vs. PHEVs). Electric vehicle market shares for EVs range from negligible to 6%, growth rates vary from zero to more than 400%, and there are both markets such as Norway and France, where nearly all EVs sold are BEVs, and markets such as the Netherlands and the US, where most EVs sold are PHEVs.

The analysis demonstrates that there are large differences in the tax structure and also in the level of incentives provided for EVs in the various markets. Linking the level of incentives and the parameters describing market dynamics suggests that there is indeed some link between the incentives provided and the uptake of EVs in a market. Clear examples are Norway and the Netherlands, where high EV fiscal incentives result in a beneficial total cost of ownership for consumers, and this results in high EV market growth rate and market share.

It is then also possible to explain why we see more BEVs than PHEVs in one market but the reverse in another market. Again, Norway and the Netherlands are good examples of this situation: While in Norway only BEVs are excluded from VAT and registration tax, in the Netherlands, the fiscal incentives apply to both vehicle types.[18] However, the effect is most pronounced for PHEVs, where the non-electric vehicle alternatives generally have relatively high CO_2 levels and are subject to high tax rates. As a result, the market share of PHEVs in the Netherlands is very high, while BEVs play only a relatively small role at the moment. In Norway, exactly the opposite is the case.

Finally, it is possible to draw conclusions about the distribution of EVs among private vs. company car customers. In general, it was found that the level of incentives provided tends to be higher for company cars than for private cars. We would therefore expect higher shares of EV among company car customers than among private car customers. However this conclusion could not be cross-checked with statistical data, as we have data regarding the number of EVs registered as private vs. company cars only for one country, Germany. At least in the case of Germany, we can confirm that indeed the share of EV is about three times higher for company cars than for private cars. Denmark is an interesting exception, where the incentive for private car BEVs is higher than for company car BEVs. However, the uptake of BEVs is very low in Denmark so far – most likely due to a generally lower acceptance on the part of private customers rather than fleet owners.

18 It is important to note that this report only focuses on fiscal incentives as provided in 2013. For some markets, for example the Netherlands, fiscal incentives were reduced or even phased out at the beginning of 2014. This has not been taken into account for this analysis.

Conclusion 2: More comprehensive study is needed of the impact of the full portfolio of policy actions to accelerate the early electric vehicle market.

We note that there are limits to the analysis within this paper. A more comprehensive assessment of policy options to spur electric vehicle growth would investigate and help understand the importance of vehicle manufacturer policy (e.g., emission standards, electric vehicle requirements), infrastructure policy (residential equipment, public charging), and electric utility policy, along with the consumer EV fiscal policy evaluated here. A more comprehensive and rigorous assessment of these other policy action areas would help inform a longer-term policy path that is not so exclusively dependent upon large initial-year taxation incentives.

The case of Germany provides an example where more detailed study is warranted. Germany is an example of a market where we would have expected a lower EV growth rate than suggested by the official vehicle registration statistics. This is due to the fact that incentives provided in Germany seem to be much lower than in most other markets analyzed here. And yet, it was the market with the second highest growth rate in 2013 (from a very low starting point, though). One possible explanation is that in 2013, many new EV models from German manufacturers were introduced into the market, resulting in relatively high registration numbers on the part of the manufacturers themselves for test drives, outreach activities, etc. Another possible explanation is that we do not take into account *all* aspects in the context of EV sales. For example, the level of charging infrastructure available is expected to also have an impact on customer behavior. For Germany, statistics suggest that there are about 2,200 publicly available charging stations for EVs (NPE, 2012)—for a total fleet of about 7,000 EVs (KBA, 2014b). A comparison of the electric grid infrastructure readiness for EVs would be an important additional issue to investigate in leading EV markets.

Another example is California where, especially for BEVs, we find a higher growth rate and market share than other markets with the same level of fiscal incentives. This could be due to many factors. One clear factor in California is the use of high-occupancy vehicle lanes for BEVs and PHEVs. This incentive is expected to provide a significant incentive to users in California, particularly in the Los Angeles and San Francisco metropolitan areas, where many EVs are registered. However, comparison of each of the vehicle markets' EV lane access incentives was outside the scope of this analysis. Another factor is the California Zero Emission Mandate (ZEV), requiring manufacturers to produce and sell EVs, which essentially also is an incentive to prompt EV adoption through manufacturers' actions—although not targeting customers directly. California also has well-developed EV action plans, infrastructure policy, electric utility engagement, consumer awareness programs, and various stakeholder involvement processes at play.

Further investigation of particular regions and cities is also an area that warrants much greater attention and understanding. Considering the far greater concentration of electric vehicles sales in particular urban areas around the world (Los Angeles, New York, Tokyo, Rotterdam, Beijing, Shanghai), analysis of the underlying factors could be critical in identifying high-priority policies to accelerate electric vehicle sales in the most likely markets.

It is also important to note that, for this analysis, only a limited number of markets were taken into account, and only two distinct vehicle models were analyzed. Quantifying and comparing incentives across different markets is a difficult task, and hence the results

can provide only an indication of general trends and relationships. More research is required for the future, and more data will become available as EV markets continue to grow. A key question for the near future will be how to transit from an early adopters' market for EVs to a mature mass market. Continued use of incentives will play an important role here. However, these incentives will have to be applied in the most efficient way possible—and they will also need to be phased out at some point in time.

ANNEX I – GLOSSARY

Base price	Vehicle market price excluding taxes
BEV	Battery electric vehicle
Company car	Car owned by a company for either company or private use by its employees
EV	Electric vehicle, including battery electric vehicle and plug-in hybrid electric vehicle
Market growth	Annual growth of market share
Market share	Market share in comparison to all new vehicle sales
Net price	Base price plus value added tax
PHEV	Plug-in hybrid electric vehicle
Private car	Car owned by a private person
TCO	Total cost of ownership, defined here as including vehicle base price, value added tax, other one-time registration tax, annual ownership taxes (for a time period of four years), and fuel/electricity costs (four years), and one-time subsidies upon purchase of a vehicle.
VAT	Value-added tax

ANNEX II – A SHORT DESCRIPTION OF 2013 NATIONAL VEHICLE TAXATION SCHEMES

Region	VAT	Tax Scheme		Subsidy
		One-time	Annual	One-time
Norway	25% BEVs exempted	• Registration tax based on vehicle weight, engine power, nitrogen oxide emissions, and CO_2 emissions. BEVs are exempted.	• Circulation tax about 350 EUR	
Netherlands	21%	• Registration tax based on the CO_2 emission level of the vehicle. BEVs and most PHEVs are exempted.	• Circulation tax based on the vehicle weight, fuel type, and CO_2 emission. BEVs and most PHEVs are exempted. • [Company car] Income tax for cars emitting more than 50 g/km CO_2 of 25% of the vehicle's catalogue value in 2013. BEVs and some PHEVs are exempted.	
US (including California)	7.3%* (8.4%)	• Registration fee around 33 EUR • Gas-guzzler tax for very fuel-inefficient vehicles		• Up to about 5,500 EUR based on battery capacity (federal); • About 1,800 EUR for BEVs and 1,100 EUR for PHEVs (Calif.).
France	19.6%	• Registration tax based on engine power. EVs are exempted.	• [Company car] Income tax based on CO_2 emission. BEVs and some PHEVs are exempted	• Up to 7,000 EUR for EVs
Japan	5%	• Acquisition tax based on engine displacement and vehicle price. EVs are exempted.	• Tonnage tax based on vehicle weight. EVs are exempted; • Automobile tax based on engine displacement. EVs are exempted 50%	• Up to about 6,500 EUR based on price difference for EVs.
Sweden	25%		• Road tax based on CO_2 emission. EVs are exempted. • [Company car] Income tax partially based on vehicle price. EVs are exempted 40%.	• Up to about 4,600 EUR based on price difference for EVs.
Denmark	25%	• Registration fee mostly based on vehicle price. EVs weighing less than 2000 kg are exempted.	• Annual circulation tax based on fuel consumption. BEVs weighing < 2000 kg are exempted. • [Company car] Income tax based on price.	
Austria	20%	• Registration tax based on fuel consumption. EVs have deductions.	• Circulation tax based on engine power. EVs are exempted. • [Company car] Income tax based on price.	
Germany	19%		• Circulation tax based on engine displacement and CO_2 emission. EVs are exempted for 10 years. • [Company car] Income tax based on price. EVs have deductions.	
United Kingdom	20%	• First year excise duty based on the CO_2 emission and vehicle price. BEVs and some PHEVs are exempted.	• Excise duty from second year of purchase based on the CO_2 emission and vehicle price. BEVs and some PHEVs are exempted. • [Company car] Income tax based on CO_2 emission and price. BEVs are exempted.	• Up to 5,900 EUR for BEVs and some PHEVs
China	17%	• Acquisition tax (10%) • Excise tax based on zvehicle engine displacement and price.	• Vehicle and vessels fee based on engine displacement and price. EVs are exempted.	• Up to 7,200 EUR for EVs

* It is sales-weighted average of states average combined vehicle sales tax rate. Source: Drenkard, 2013, NADA, 2013.

Norway

Vehicle taxation in Norway is generally very high. VAT is 25%. In addition, there is a one-time registration tax that depends on vehicle weight, engine power, nitrogen oxide emissions, and CO_2 emissions. The annual circulation tax, in comparison, is relatively low (about 350 EUR). The total tax burden at vehicle purchase (VAT, registration tax) accounts for approximately 40 to 50% of the vehicles' total price. Full battery electric vehicles are exempt from registration tax and VAT. In comparison, plug-in hybrid vehicles do not qualify for an exemption, but are subject to a 15% tax deduction on the weight tax for the extra weight of batteries.

Netherlands

In the Netherlands, VAT is at 21%. In addition, there is a one-time registration tax that depends on the CO_2 emission level of the vehicle. Since July 2013, cars emitting less than 95 g CO_2/km (gasoline) or 88 gCO_2/km (diesel) are exempt from registration tax. Furthermore, there is an annual circulation tax, based on the weight of the vehicle. Cars emitting less than 110 gCO_2/km (gasoline) or 95 gCO_2/km (diesel) are exempted from road tax. The total tax burden (VAT, registration tax, annual circulation tax for four years) accounts for approximately 30% of the vehicle's total price for the Renault Clio, but can go up quickly for vehicles with high CO_2 emission levels. Full battery electric vehicles, and also all current plug-in hybrid vehicle models, are exempt from registration and annual circulation tax. For the private use of company cars that exceed 500 km a year, income tax is levied on cars emitting more than 50 g/km CO_2 of 25% of the vehicle's catalogue value in 2013. From 2014 on, owners of cars emitting less than 50 g/km CO_2 will also be charged some income tax at a lower rate than that for owners of vehicles with higher emission.

United States

In the US, taxation can be quite different between individual states and even individual cities. The average VAT (i.e use/sales tax in the US context) level ranges from zero to 9.4% in different states. In California, the average sales tax is 8.4%. Apart from a small annual registration fee and a gas-guzzler tax for very fuel-inefficient vehicles, no vehicle taxation is taken into account in this paper for either the US or California. For electric vehicles, there is a direct subsidy at the federal level of up to about 5,500 EUR, depending on the battery capacity (i.e., rates are somewhat lower for plug-in hybrid vehicles than for full electric vehicles). In addition, California provides another one-time incentive of about 1,800 EUR for full electric vehicles and about 1,100 EUR for plug-in hybrid vehicles.

France

Besides VAT (19.6%), there is also a one-time registration fee for vehicles in France. The rate for the registration tax is based on engine power and varies by region. For Paris, the amount equals about 200 EUR for Renault Clio. Hybrid and electric vehicles are exempt from this registration tax. In addition, there is the French bonus-malus system, with a one-time penalty for passenger cars above 135 gCO_2/km (in 2013). Vehicles emitting less than 110 g CO_2/km can qualify for a subsidy that is between 200 and 7,000 EUR, but the subsidy is capped at maximum 30% of the vehicle purchase price including VAT. There is additional income tax for private use of company cars. The tax base depends on CO_2 emission. Vehicles emitting less than 50 g CO_2/km would not be levied income tax. Thus, BEVs and some PHEVs are exempted from income tax.

Japan

Besides a 5% VAT, there is an additional one-time acquisition tax for the purchase of a car in Japan. This acquisition tax is based on vehicle price, with the tax rate depending on the engine displacement of the vehicle. For cars above 600 cm3, the rate is 5% of vehicle base price. There are two annual taxes to be paid: a) tonnage tax, which is based on vehicle weight, and b) automobile tax, which is based on engine displacement. There are specific rules for vehicles meeting certain fuel consumption and emission targets that are eligible for tax reduction. Full battery electric and plug-in hybrid vehicles are exempted 100% from acquisition and tonnage tax and 50% from automobile tax. Additionally, there is a direct subsidy available upon purchase of an electric vehicle (both full electric and plug-in hybrid vehicles). This one-time subsidy takes into account the price difference between an electric vehicle and a comparable conventional vehicle, and is capped at a maximum of about 6,500 EUR.

Sweden

VAT in Sweden is 25%. There is no registration tax, but an annual road tax that depends on the CO_2 emission level. Currently, there is also a direct subsidy for all vehicles emitting no more than 50 gCO_2/km. This purchase incentive is 35% of the price difference between the "super green car" and its conventional counterpart, and capped at a maximum of around 4,600 EUR. For private use of company car, there is a personal income tax partially based on vehicle price. Electric vehicle and plug-in hybrid vehicles enjoy 40% off the tax compared to the taxation value of the corresponding conventional vehicles in 2013 and reduction down to the taxation value of the corresponding conventional vehicles from 2014.

Denmark

In Denmark, VAT is at 25%. There is a high one-time registration fee that is mostly based on vehicle price. In addition, there is a relatively small annual circulation tax, based on fuel consumption of the vehicle. Registration tax for the Renault Clio exceeds the base vehicle price, and for expensive vehicles is even higher than the actual price of the vehicle. Electric vehicles weighing less than 2000 kg are exempt from registration and circulation tax. For private use of company cars, personal income tax will be added based on vehicle price.

Austria

VAT in Austria is 20%. In addition, there is a one-time tax ("NoVA") upon purchase that is based on the fuel consumption of a vehicle. There are deductions for NoVA, in particular for vehicles with an emission level of less than 120 gCO_2/km, and hybrid vehicles. As a result, the Renault Clio is largely tax-exempt even though it is not an electric vehicle. There is also a monthly circulation tax, based on engine power, with electric vehicles being exempt from it. For private use of a company car, 1.5% of gross vehicle price will be added to the driver's monthly personal income base up to 600 EUR.

Germany

A VAT rate of 19% applies. There is no registration tax. Annual circulation tax is based on engine displacement and CO_2 emission level. Electric vehicles are exempt from circulation tax for 10 years. However, annual circulation tax is relatively low (about 20 EUR for the Renault Clio). For private use of company car, 1% of vehicle price will be added to monthly income tax base, while EVs would enjoy gross vehicle price reduction based on batter capacity.

United Kingdom

The UK charges an annual vehicle excise duty for cars. The vehicle excise duty rate is based on the CO_2 emission level of a vehicle update to 35%. The rate for first year is different from the following years. The threshold for tax exemption is at 130 g CO_2/km for the first year and 100 g CO_2/km for all other years. For the Renault Clio, vehicle excise duty is zero or close to zero. In addition, full electric and plug-in hybrid vehicles with less than 75 g O_2/km qualify for a one-time bonus of up to about 5,900 EUR. The level of VAT in the UK is 20%. The UK also has set a different tax rate for private use of company cars to add to the driver's personal income tax base based on CO_2 emission. Thus full electric vehicles are totally exempted.

China

In China, VAT is 17%. There is an additional 10% acquisition tax for all vehicles. A one-time excise tax, based on vehicle engine displacement, is added on top. An annual "vehicle and vessels" fee, again based on vehicle engine displacement, is also charged. Energy efficient vehicles that exceed Phase III fuel consumption standards are eligible for a 50% reduction. New energy vehicles (NEVs), including BEV, PHEV, and FCEV, are fully exempted. There are two types of direct subsidies provided for new passenger vehicle purchase. One is an incentive of around 360 EUR for vehicles with an engine displacement of less than 1,600 cm3, meeting fuel consumption targets that are more stringent than the Phase III standards. Another subsidy is for NEVs, including full electric vehicles and plug-in hybrid vehicles. The amount of NEV subsidy ranges from about 4,200 to 7,200 EUR, depending on the range of the battery. The Renault Zoe qualifies for about 360 EUR energy-saving subsidy and 6,000 NEV subsidy (the maximum amount of 7,200 EUR is only for vehicles with a battery range of more than 250 km).

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