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"Effectiveness of financial incentives for stimulating BEV uptake"

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Summary

This paper gives a unique insight in the effectiveness of BEV (Battery Electric Vehicle) incentives in multiple European countries. An area of interest is the chronology of the introduction of different EV incentives, where the relation between EV uptake and incentives has been studied, analyzed and compared. The second focus area is on translating the different incentives into the real benefit for the user/owner in terms of purchase price and Total-Cost-of-Ownership of BEV's compared to conventional powered vehicles. Also the availability of EV models has also been identified as a crucial boundary condition in the success of EV uptake and therefore the expected EV´s which will come to the market has been analyzed.

Market development, EV (electric vehicle), Incentive, Policy, Taxation, Subsidy

1 Introduction & background

By the continuously improving, updating and expending our research on the relation between EV uptake and different boundary conditions, we have been able to create new insights. Our goal is to contribute to advancing the knowledge for decision makers and policy makers, by informing them and supporting them with (policy) advice in order to effectively accelerate the uptake of EV's.

Earlier research

From 2014 to 2017, FIER Automotive, as one of the partners in the EU funded project I-CVUE, analysed the effectiveness of financial incentives to stimulate BEV sales. This provided unique and breakthrough insight in a) the various incentive schemes across Europe; b) the actual impact of incentives on the purchase price and Total-Cost-of-Ownership difference vis-à-vis ICE vehicles; c) the effect of the incentives on the

market-uptake of BEV's and d) the required threshold a financial incentive needs to overcome, in order to have any meaningful impact at all.

We generated first indicative insight in the price-elasticity of the demand of BEV's in relation to incentives, branded as the "incentive-elasticity of BEV demand". Based on our analyses we were able to define which measure had at what point in time, which impact on BEV sales and translate this into predicted impact of incentives, like for example that the in May 2016 introduced German incentive scheme would not attain its goals; b) calculate which level of financial purchase incentives would be needed in the Netherlands to achieve substantial BEV's sales among private consumers; c) proof that PHEV incentives are in general substantially cannibalising on BEV sales.

As part of these projects, we also orientated on the synergetic effectiveness of combining incentives, like for example by indicating the additional effectiveness of road privileges for BEV's (like bus lane access, zero emission zones) in cities where the Total-Cost-of-Ownership (TCO) is already positive.

We investigated the local boundary conditions of certain regions (for example commuting patterns) as well critical success factors like the availability of charging infrastructure. One of the (logical) conclusions was that the uptake of EV's and hence the effectiveness of incentives, very much depended on the availability of vehicles meeting customer demands. Changes in incentives, as well as introduction of EV's, showed clear hikes in sales figures.

New in 2019 study: Incentives and local regulations more common and increased BEV portfolio

Meanwhile the supply market is becoming far more developed, compared to the early days of EV's 2010-2016, when the number EV-models on the market was minimal and the vehicle characteristic were far from meeting user demands. Moreover, more countries have introduced incentives and regulations for stimulating EV's and/or discouraging the use of ICE's.

Car manufacturers have increased their range of BEV's into multiple segments including SUV's and larger models. And almost without exception the maximum driving-range of BEV's has improved substantially due to larger batteries and hence the gap with the range of petrol-cars has become smaller. Although the TCO/purchase price has not fluctuated very much, the suitability of EV's has very much improved, providing evidence that this is a strong driver for EV uptake. As part as a future outlook, we will in this paper also describe the expected strong growth of the number and portfolio of BEV-models on the market, as a first indicator of expected future sales growth.

In this paper we present the first results of a long term study in which we continue to assess the effectiveness of incentives, in perspective to the growing vehicles range and improved characteristics of the EV's on the market, Our main aim is to assist public policy makers in designing effective incentive programs (until overall TCO neutrality and until around 2025 purchase price parity is reached), we will update the overview of incentive programs in Europe, the impact on the comparative TCO and purchase price and the effectiveness of the programs till at least 2020, creating a valuable "longitudinal" study from 2014 till 2020.

This we will do together with the University of Twente, in our work as partners in the EC cofounded project ProEME (Promoting Electric Mobility Europe)Another and based on the market data of the European Alternative Fuels Observatory [3] (EAFO), which FIER is managing as lead partner of a consortium, on behalf of the European Commission, DG Move.

As first step we have calculated, for a limited number of countries (NL, D, A, N, DK) the current TCO and purchase-price (dis)advantages of a VW Golf. We have chosen this vehicle, because has been available in all these countries in electric, petrol and diesel version and hence this enables to assess the residual value. This method has a number of limitations but is a first step to create insight on the recent 2018 figures.

(see methodology, Appendix I)

To analyse the effect of incentives on the EV uptake in several European countries, we created a chronology of car-related incentives per country, linked to both the total number of electric vehicles (BEV and PHEV) and the market share of new registrations in percentages (BEV and PHEV).

The different developments of EV uptake in relation to EV incentives have been studied. We have studied the last 10 years of incentive development. The countries which we have studied are the Netherlands, Austria, Sweden, Germany, Norway, UK and Denmark. Market share and fleet size numbers were retrieved from EAFO [3] and information about country specific EV-incentives were retrieved from official governmental websites. For each country an EV expert with knowledge about EV incentives provided input and feedback on incentives and their estimated influence on EV uptake.

The focus is on BEV, but in our study we have also included the developments of PHEV sales/incentives. In the figures below we taken Norway, Denmark, Germany and the Netherlands as example.

Ongoing research during 2019: what further results can you expect from us to be

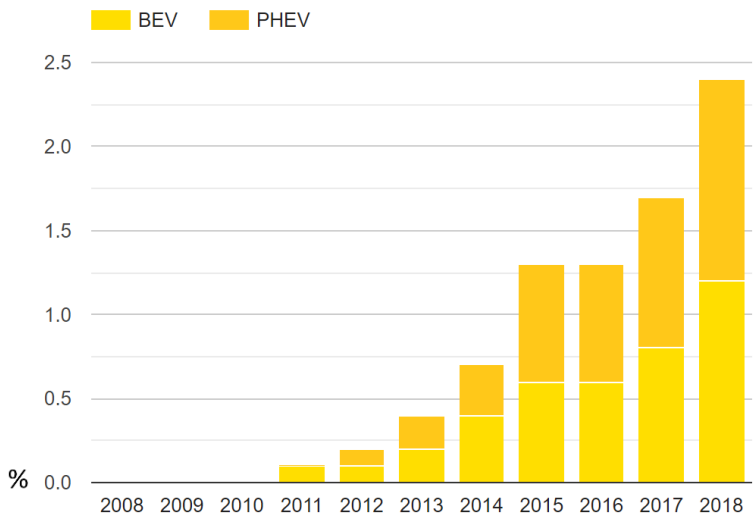
During 2019 will improve and expand the analyses further. For example, we will differentiate between business and private market, as many of the incentives throughout Europe either target private or business users, with high variation of uptake between these two segments. In line with this, we will include in upcoming analyses also the cost (dis)advantages for the employees, driving company-cars.

To further improve the predictability of our "price elasticity of demand" as a powerful tool to predict incentive effectiveness, which we started modelling in 2017, we need to increase the number of countries analyses as well as that we will need to dive deeper in the specifics of the market segment (like business, versus private). In order to circumvent the risks that our results are biased by the geographic marketing (pricing) policies of car manufacturers, our next step will be to base our calculations on a mix of vehicles, instead of just one model from one manufacturer. Actual availability per geographic market and delivery lead-time will also be taken into account.

Moreover, we have so far focussed at the C-segment passenger cars. With the growing availability of (long range) BEV's in other vehicle categories, it is high on our wish list to see the impact of the comparative TCO/Purchase-price of these vehicles versus their diesel/petrol sister-models, on the EV uptake.

Hence this EVS32 papers is not the end-result of our 2019 study, but the starting-point first results.

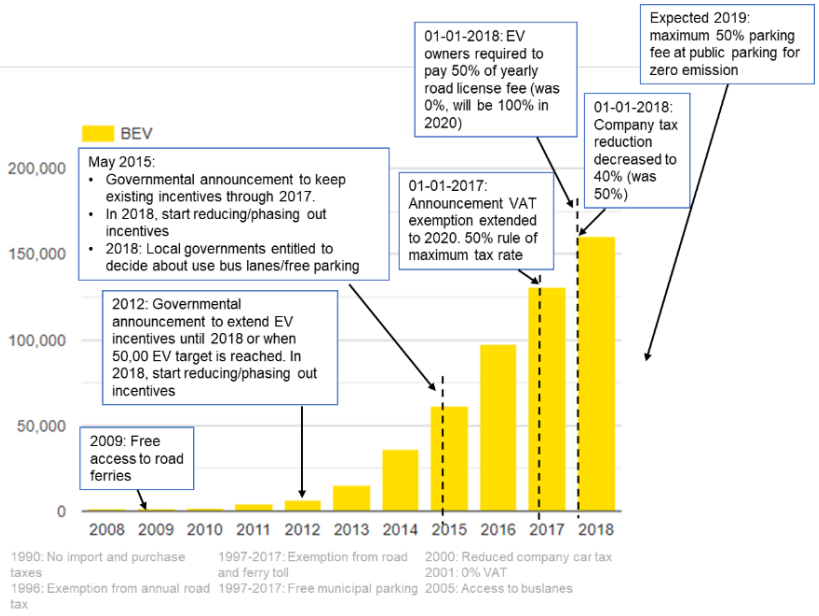
2 Development of EV incentives, an evolving landscape



BEV financial incentives have become more common in most European countries, but with large variations in success, where in some countries the EV uptake is substantial and in others neglectable. In general, the EV sales in Europe are growing. The sales of EV's are more or less equally divided between BEV's en PHEV's.

EV share new registration in Europe, source EAFO

Norway



Norway is a prime example of a country where EV uptake is considered successful. The quantity as well as the quality of the incentives ensured a growing BEV uptake, which was in 2018 at 31,2% of the total new BEV registrations. The national financial incentives have got a large impact on the TCO, but also non direct (financial) incentives play a major role in the successful uptake of EV's. In some parts of the countries, mainly in larger cities like Oslo, the uptake of EV´s is significantly higher than the countries average.

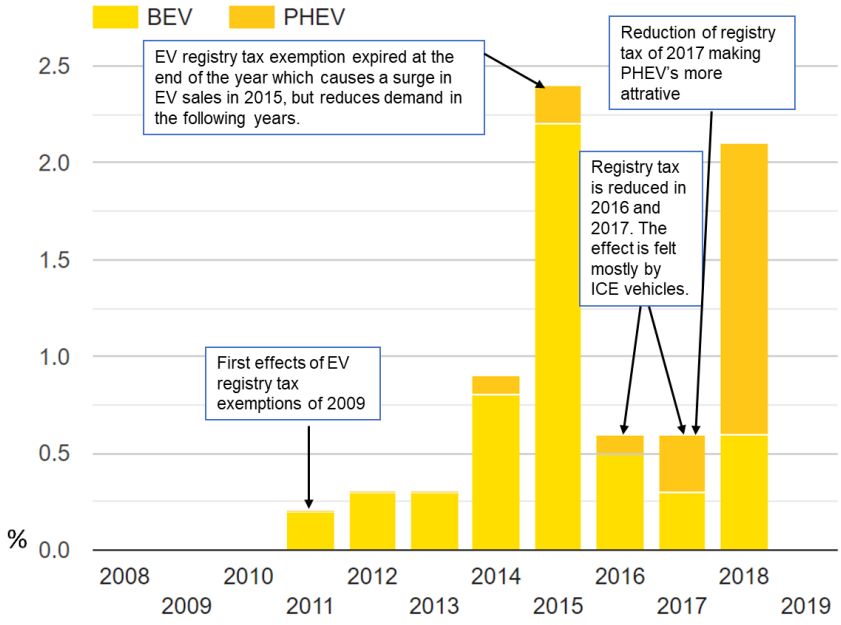
Figure 2: Market share EV's per year in Norway

This is because the non-direct (financial) incentives have got a bigger impact on EV usages than in other parts of the country (parking advantages, toll roads, etc.).

The incentives in Norway were introduced at an early stage, when there were hardly EV models on the market. Although the financial incentives, did not change much over the years, the uptake of EV's continued to grow. The availability of suitable EV's models has a significant role in the successful uptake as well. Also, the introductions and continuation of incentives were communicated well in advance, as well is the reduction of these incentives, giving the market a clear perspective on future developments

From the year 2015 there was a tipping point where a the PHEV share of new registrations grew significantly, even cannibalising on the sales of BEV´s. However, with almost half of the new registrations being EV´s, the EV uptake in Norway is still very successful.

Denmark



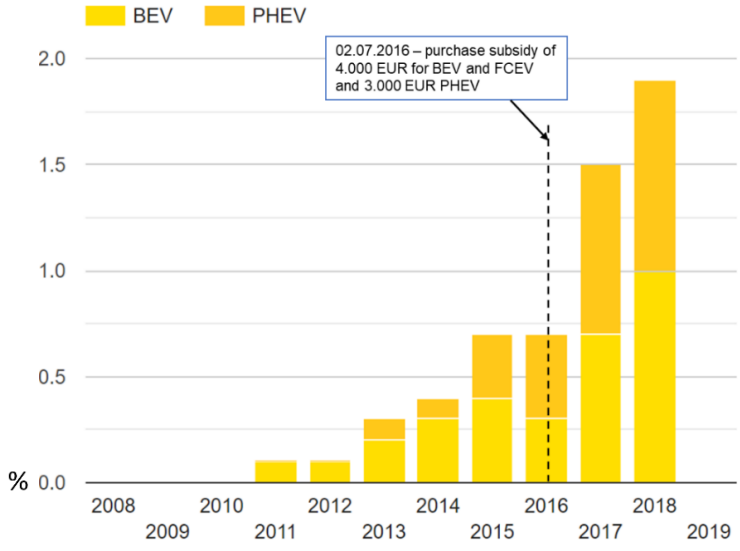
In Denmark the quantity of EV incentives is not significant but the financial incentive with regards to the registration tax has a rather big impact on the TCO. There also have been a big increase of EV sales in the end of 2015 because of the expired exemption on EV registry tax.

In the following years the growth of EV market share reduced, also because of a reduction on registration tax which effected mostly ICE vehicles. The growth of the PHEV market share in 2018 is also significant, following the reduction of registration tax on PHEVs.

Figure 3: Market share EV's per year in Denmark

The changing financial incentives have had significant impact on the changes in EV sales, both for BEV's as well as for PHEV's.

Germany



The sales of BEV have been increasing over the last decade in Germany, however, the BEV share of new registration was in 2018 only 1% and 0.85% PHEV.

The quantity of national incentives is a €4.000 purchase subsidy which was introduced in 2016 for BEV's (and €3.000 for PHEV's), which didn't have a significant impact on the EV sales in that year. The total sales of EV's in 2016 is equal to 2015 sales. The effect was relatively low, because even with the subsidy, there was still a big difference in the TCO calculations between ICE and BEV.

Figure 4: Market share EV's per year in Germany

The TCO 'threshold' where there is a significant change in uptake was not reached. The sales of EV's doubled however in 2017, but did not grow in the same pace in 2018.

The Netherlands

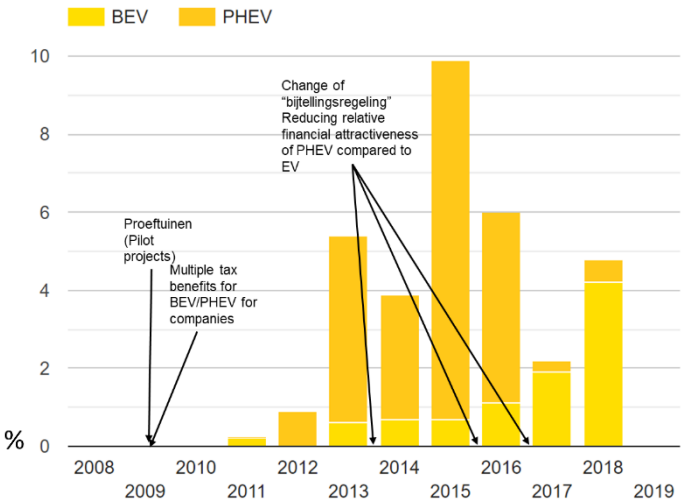


Figure 5: Market share EV's per year in the Netherlands

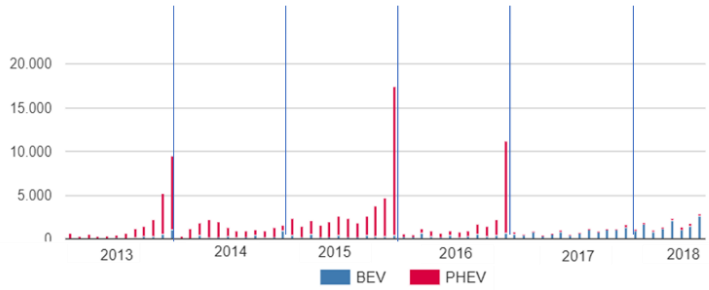
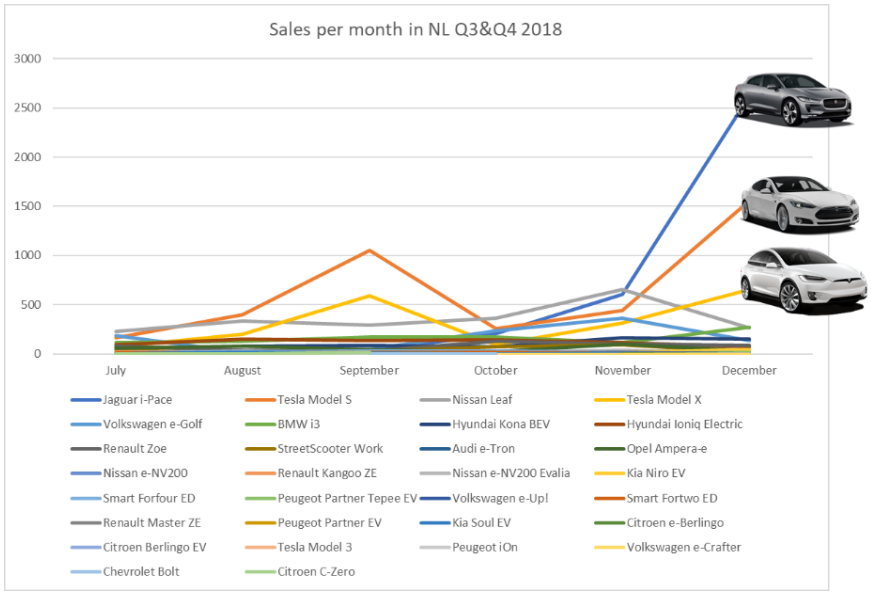


Figure 6: Sales EV's per month in the Netherlands

In the Netherlands there are multiple financial incentives to stimulate the uptake of EV's. In most other EU countries the sales of EV's shows a steady growth each year. In the Netherlands however, there are multiple changes over the last decade for the sales of PHEV's. These significant changes in PHEV sales accrued right before the change in the percentage of benefit-in-kind (BIK). Shown in the figure below, the sales in the last month of year 2013, 2015 and 2016 increased significantly, where the market made use of the incentive right before it became less attractive.

Although there were positive and negative changes in the PHEV sales in the Netherlands, the BEV sales grew slowly, reaching 5,4% in 2018. Where in 2015 there the sales of PHEV reached 9,2%, the share of new registered PHEV's reached only 0,6% in 2018. The effect of BIK changes is seen in the PHEV sales figures.



There is a significant growth of BEV sales in 2018, right before there was a change in the BEV BIK for vehicles with a higher price tag. The benefit in kind of a BEV is 4%, but since January 2019 the BIK for BEV with a higher list price than €50.000, the BIK for every euro above this threshold is 22%. Of course the availability of the just introduced Jaguar i-Pace was limited until the end of 2018. Jaguar sold in total 6.893 i-Paces in 2018 of which 3.495 to Dutch customers.

Figure 7: Market share BEV's per month Q3 Q4 2018 in the Netherlands

The combination of these factors assured for a significant increase of BEV sales in the last month of 2018. At the EVS32 we are able to identify the sales in the first months of 2019, to compare them to earlier sales figures of 2018.

3 Financial incentives put in to perspective – TCO

A growing number of countries has also set goals for 2025 and 2030 for zero emissions vehicles sales percentages. In order to reach these ambitious goals, financial incentive policies need to become much more effective. This will only be attained when the incentives create a TCO advantage for BEV's vis-à-vis ICE vehicles and make the purchase price / TCO more attractive for BEV's.

This means that for example purchase subsidies, tax and/or VAT exemptions, cannot be evaluated in isolation, but need to be combined with the effects of stimulation measures like circulation tax advantages, parking/charging benefits, reduced toll-fees etc. This is a complex exercise, taking in mind the differences and specifics of the various tax systems in Europe and the many exemptions, but also due to the yearly changes in the EV incentive schemes. The same can be said for countries with a progressive CO2 based purchase tax regime versus countries with almost no purchase tax: The effect of an additional subsidy or tax reduction will have a completely different effect in each of these countries.

Many countries stimulate the sales of EV's. This varies from the exemption of road tax, purchase subsidies, lowering purchase tax up to the exemption of VAT. All national incentives schemes have an influence on the purchase price and/or the operational costs of a vehicle. Some of these incentives only effect private ownership, others only business usage and some have effects on both. All different national financial systems in combination with complex incentives, make it hard to create a comprehensive overview of the effect on the cost of ownership. In sum: Whereas authorities assume that a financial incentive (like the Kaufprämie in Germany) will create a substantial difference, the actual effect is often very different and more complicated. In reality the effect can only be predicted by calculating the impact on the TCO on the purchase price.

Purchase price

In the following graph a overview of the purchase cost of the vehicles are shown per drivetrain type and per country.

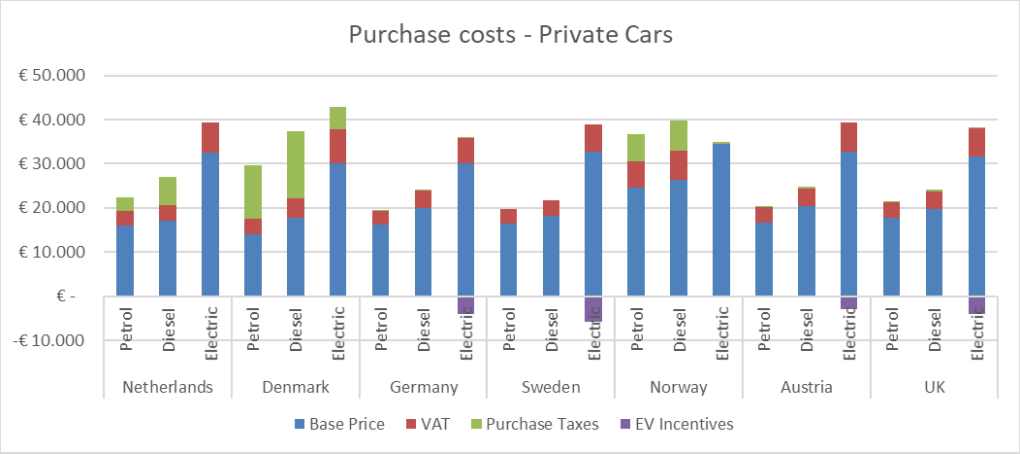


Figure 8: Purchase cost comparison for private consumers between VW Golfs (Petrol, Diesel and Electric)

The base prices of the vehicles deviate between the countries, but not significantly. Some inserting observations are that there are significant differences in the purchase tax between different countries. The Netherlands, Denmark and Norway apply purchase taxes, and give reductions (DK) or totally exempt (NL & NO) to EV's. A strong tax advantage, which can be applied by the national government to make EV's financially more attractive. It is also noticeable that only Norway doesn't charge VAT for the purchase of an EV. The UK, AT, DE and SE are applying purchase subsidies to stimulate the EV uptake.

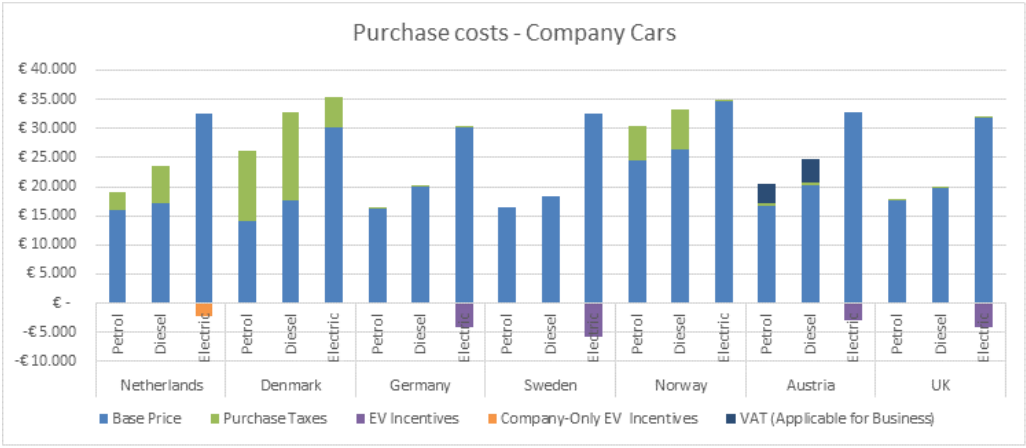


Figure 9: Purchase cost comparison for companies between VW Golfs (Petrol, Diesel and Electric)

The vehicle purchase price for a company is different from a purchase price of a consumer. For companies the VAT is usually deductible, and there are some other tax advantages / purchase subsidy incentives. With regards to the VAT, there is one exemption in Austria, where companies cannot deduct VAT for petrol and diesel vehicles. This has an interesting effect on the purchase price in Austria.

The total result is that for this specific comparison of VW Golf's, that the EV purchase price is slightly cheaper in NO for a private person, and in the other countries more expensive. The purchase price of a vehicle, can be calculated to a depreciation by calculating the residual value. Based on the current research of depreciation (as explained in the methodology), the relative depreciation of an EV is in most countries equal or lower than their ICE equivalents. Because the total purchase price of a BEV is higher, the total (absolute) depreciation of an BEV is higher in most countries.

Where BEV's were considered to have a lower residual value, for example because of the uncertainties with regards to the quality of the battery, or the newer model quickly outperforming the previous version, it seems no that the depreciation of the BEV's are stabilising and becoming more comparable to ICE's. On the other hand the changes in perspective on residual value of (old) diesel vehicles, is increasing the depreciation of these diesel powered vehicles.

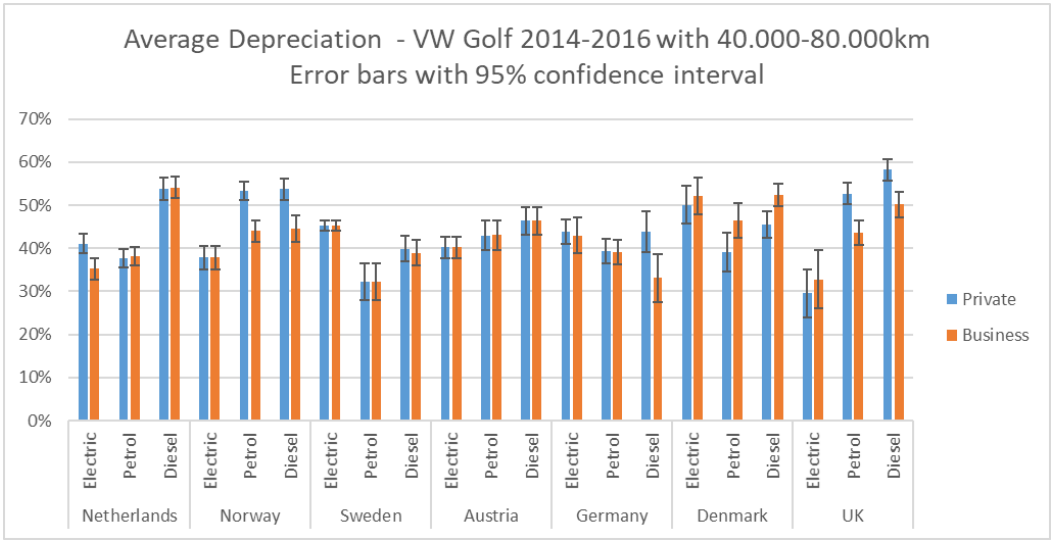


Figure 10: Average depreciation between VW Golfs (Petrol, Diesel and Electric)

Based on the residual value figures we have been able to calculate the depreciation of these vehicles. Also we have added the other operational cost like insurance, road tax, maintenance and energy cost to complete

the followings graph showing the TCO. As mentioned, this TCO is based on 15.000km per year and a 4 year ownership.

The following graph it is easy to identify that the depreciation of BEV's is higher than ICE's, except for NO. In all countries the price of energy cost (for the ICE's this is of course diesel and petrol), the price of electricity is lowest. Also the road tax for BEVs is in most countries reduced or completely exempted.

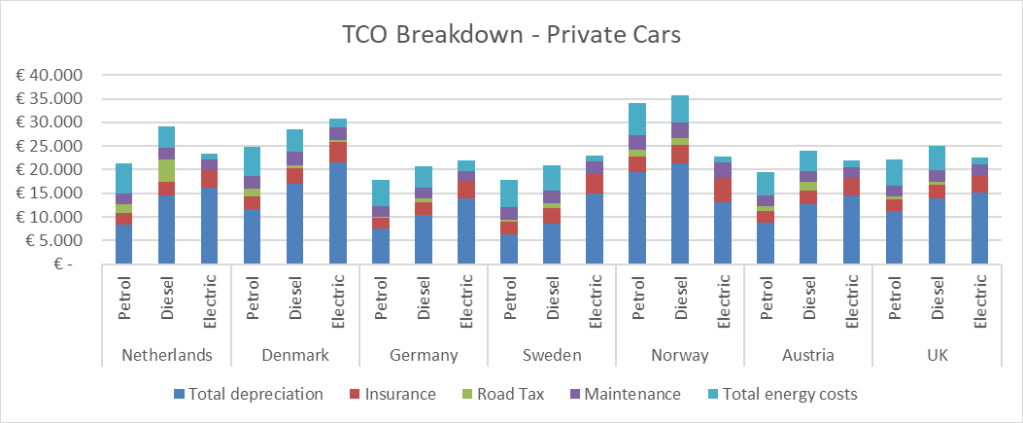


Figure 11: TCO comparison for private consumers between VW Golfs (Petrol, Diesel and Electric)

This results in an overview where only in NO the business case for an EV makes more sense than driving an ICE. Driving an diesel or a petrol car, is also in general quite expensive. In NL, AT and UK TCO differences are limited, and in the other countries the BEV business case is far from comparable with ICE's.

The same principles apply for the TCO of the company cars. Because the purchase price and residual value is different, also the depreciation is different. It is however quite usual for a company car to drive more than 15.000km per year, and because of the lower operational cost, the TCO of an BEV will than become more attractive. On the other hand, making more than 15.000km per year with an BEV, will demand some changes in driving patterns in terms of charging. The new longer range EV's would be easier suitable for these higher km's.

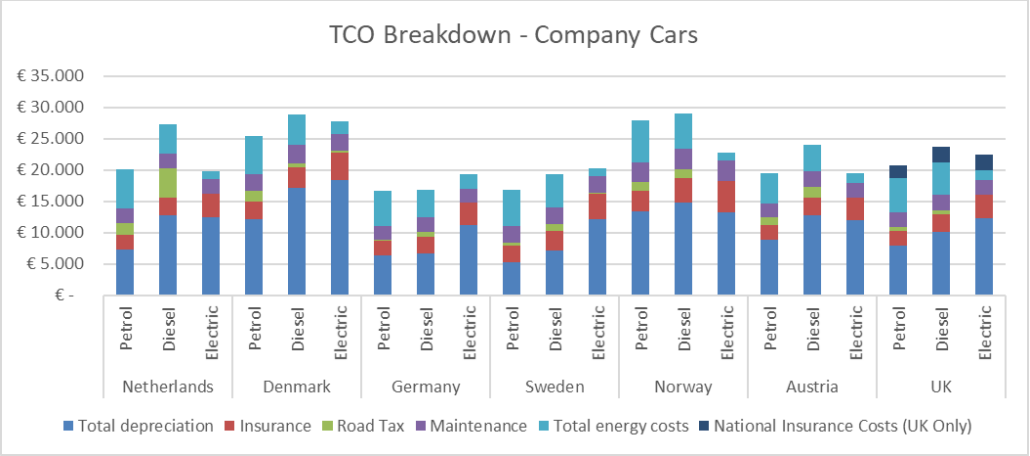


Figure 12: TCO comparison for company cars between VW Golfs (Petrol, Diesel and Electric)

Again, the NO business case of a BEV is better than in the other countries. In NL and Austria the TCO is similar with a petrol car, making it an more interesting case. With regards to the TCO of a company, also the BIK plays an important role in vehicle choice.

Impact of a higher capacity utilisation

The TCO calculations have been focused on 15.000 km per year, as this is a relative normal yearly mileage for private consumers. However, company cars are often driven with a higher yearly mileage. Although we not able to fulfil a complete analyses with regards to the higher yearly millage per year in all countries yet, we did put it in to perspective for the Netherlands.

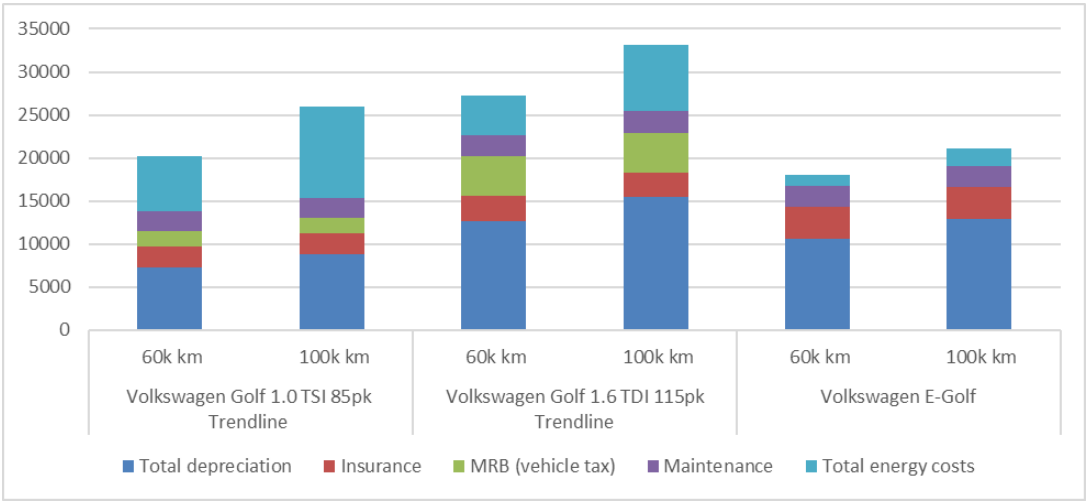


Figure 13: TCO comparison for company cars between VW Golfs (Petrol, Diesel and Electric) at 60.000km and 100.000km

The TCO increases when more kilometres are driven, but because of the lower operational cost of an EV, the difference between the 60.000 km and 100.000 km with the electric Golf is significantly smaller than the difference with the ICE equivalents.

4 Price elasticity

We have looked at the purchase price and TCO differences between BEV´s and ICE´s in multiple countries, and the relative EV sales in these specific countries to investigate if there is a the relation between these factors and if yes, how strong it is. Because the significant differences of purchase price and TCO between company ownership and consumer ownership, we first need to identify which part of the EV uptake is a company or a consumer purchased vehicle.

We expect to see here an even stronger relation, compared to the draft graph we showed in the abstract. From a scientific point of view we can only say that the R^2 value is showing a medium to strong relation, but not very strong. It is the expectation that this research will be finalized and could be presented at the time of the presentation at the EVS32.

5 "Vehicle supply matching the demand": A critical condition for incentives being effective

Decisive for the uptake of BEV's is that the usability of BEV's matches the needs of the BEV buyer/driver and that the vehicle is accessible in terms of pricing and operational cost.

The usability depends partly on the boundary conditions in which the vehicle is used, in terms of mobility needs, the local geographic, climate and other conditions. Our earlier research showed that these boundary conditions (like geography, climate, general commuting distances) are influential but not decisive for BEV uptake. Also the availability of charging infrastructure has shown to be less of a driver for uptake (chicken-egg), as BEV uptake seems to drive the charging network expansion more than vice versa. Whereas authorities assume charging infra-structure to be a driver it is a facilitator for BEV uptake.

On the other hand the availability of vehicles meeting the buyer/driver demands, has proven to be crucial and an accelerator for BEV sales, provided that the comparative TCO and purchase price are attractive. Since 2012 the number of available vehicles has grown substantially and now covers now multiple vehicle segments. Moreover, vehicle capabilities in terms of range and charging speed have increased. Hence the available vehicles match better with the user needs and offer a broader choice. Whereas in the past, the results of BEV incentives where very much limited by the lack of available vehicles meeting consumer-demands, the effectiveness of incentives by now, can be analysed and predicted much more accurate, because of the availability of the vehicles.

Forecast of available EV models

We have analysed the different EV models which will come on the European market between 2019 and 2023. We have identified the models and categorised them in Economy, Premium and Luxury. Also we included the battery size of the models.

BEV's

See below the overview of announced BEV models being introduced on the European market.

Number of BEV's	2019	2020	2021	2022	2023	TOTAL
20 kWh -< 30 kWh	2	2		3		7
30 kWh -< 40 kWh	7	1				8
40 kWh -< 50 kWh	2	1	3			6
50 kWh -< 60 kWh	5	8	1	1	1	16
60 kWh -< 70 kWh	7	7	6	1	3	24
70 kWh -< 80 kWh	1	8	4	3	2	18
80 kWh -< 90 kWh	4	5	4	2	3	18
90 kWh -< 100 kWh	2	4	3	3		12
100 kWh - 110kWh	2	4	7	1	2	16
110 kWh -< 120 kWh			1			1
120 kWh -< 210 kWh		2		1	1	4
NA	6	7	5	1		19
Total	38	49	34	16	12	149

There seems to be significant increase in models being offered in a BEV drivetrain in the upcoming years. The OEM's who are included in the overview are mainly well represented brands in Europe, however, there are several expected introductions from OEM's which are not on the European market (for example from China and India).

Also the sizes of the batteries will increase in the upcoming years. Most BEV models currently on the road have got a battery smaller or equal to 30kWh (with the exemption of Tesla model S and X). From the total of 149 models introduced in the upcoming 5 years, 75% will have a battery of 60kWh or larger.

Charging

This is an important observation, which will have an significant effect on the charging behaviour of EV drivers:

- Current slow charging systems will not be sufficient for the future needs (charging 100kWh vehicle from 20 to 100% with 2,7kW will take 30 hours). Therefore they will need to be upgraded.
- Several BEV models are going to have 3 phase AC 11kw and 22kW solutions. Expected is that slow charging will also go towards DC solutions.
- Also the current fast charging network and standards will need to change to fulfil the needs of longer distance traveling.
- Fast charging will be between 70kW and 350kW, mostly via a CCS type 2 socket.

PHEV's

The announced introduction of PHEV´s on the European market are combined in the overview below.

Number of PHEV's	2019	2020	2021	2022	2023	TOTAL
5 kWh -< 10 kWh	1					1
10 kWh -< 15 kWh	16	9	6			31
15 kWh -< 20 kWh	7	4				11
20 kWh -< 25 kWh	3	1	2	1		7
25 kWh -< 30 kWh	6	5	7	2		20
NA		1				1
TOTAAL	33	20	15	3	0	71

The total number of announced PHEV´s introductions are lower than the BEV´s. Although most PHEV´s which will come this year to the market, will have a battery between 10 and 15 kWh, there is also a growth noticeable in the battery sizes. Currently, most PHEV´s on the road have a relative small battery, providing electric ranges up to 50 km´s. With the growing size of PHEV battery sizes, the utilisation of the vehicles will change.

6 Conclusions

After gathering the information and analysing the costs and EV uptake, we have made the following observations and drawn the first conclusions:

- In general, the market share new EV as well as more specific the BEV registrations increases in the covered countries in a continuous flow. there are a number of exemptions, with logical explanations. For example shows a strong fluctuation in PHEV's sales due to withdrawal of the incentives PHEV, which gave an impuls to BEV sales. Fluctuations of EV sales in Denmark can also be clearly be attributed to incentives fluctuations. We see even higher fluctuations if we observe it on a monthly basis.

- Based on the first results we can already conclude that there is stronger differentiation, between countries with incentives which actually create favourable TCO's and purchase prices difference for BEVs versus ICE's.

- There are differences between the countries regarding focusing on stimulating business versus private EV use. The Netherlands and Austria have a (partly) positive EV-TCO for only businesses, whereas Norway shows a positive EV-TCO for only private owners.

- There are differences between the countries with regards to stimulating PHEV's and BEV's. There are countries only focussing on the stimulation of BEV's, while other countries like Norway recently started stimulating PHEV's as well. In general, most countries increase the financial incentives to increase BEV uptake, and lower the incentives with regards to PHEV's.
  It's clear that making the PHEV's relatively more attractive, has a negative influence on the sales of BEV's. Vice versa, making the purchase tax higher for PHEV's, the BEV's will get more attractive. This is a logical effect that also is applicable when the financial advantages are larger between EV's and fuel-efficient petrol and diesel vehicles.

  The reason for Norway to start PHEV incentives, was also to create continued EV-sales by making EV's more attractive for users for which a BEV did not match the driving needs and hence a PHEV was more suitable.
  With the current availability of longer range EV's, it would be good to evaluate this reasoning and to renew the analyses if the additional market share for PHEV still justifies, the cannibalisation of PHEV on BEV sales.

- As concluded before the VAT exemption in Norway has a strong impact on the private market, for the new sales, as well as for the pre-owned market (because the higher residual value, it also has a strong effect on the new sales for business usage). The VAT exemption in Norway is approved by the EFTA by a detailed 'State aid analyses' and agreed upon with the EU.
  There are several European countries where there are exemption rules with regards to VAT on company cars like for example in Austria, but not for sales to consumers. The regulation like applied in Norway, is a driver for EV-uptake for new and second hand sales It is recommendable to consider applying it in EU countries as well.

- The effect of incentives is visible in most countries, but at the same time, the relative growth in sales of EV's is still limited.

- It doesn't matter how good the incentives are, if the buyers do not understand it or if the incentives are not consistent and there is no long-term-policy about the advantages (what happens with the road tax, can I charge against reasonable prices, and what about the residual value) the effect will be minimal. Consistency and long-term stability appear to be crucial.

- The intentional results indicate there is a threshold where the sales of EV's will show progressive uptake and that the difference in purchase price between BEV's and comparable petrol vehicles must be brought to a minimum, to accelerate BEV sales .

  Whereas purchase price is a important evaluation criteria for private vehicles sales, TCO is important for both private and business sales. Also for TCO there is a threshold for the level of TCO-advantage an BEV should have over an ICE vehicle. As ICE's have so far in almost all use cases been more suitability for meeting the mobility needs, than BEV's and due to the "hassle" (Finding chargers, planning ahead for a longer trip, waiting during fast charging) when driving a BEV, this TCO of the BEV needed up-till-now to be substantial positive in comparison to a ICE. However, the suitability quickly improves and hassle-factor is quickly getting less, now that mid-sized BEV's with 60KWh battery packs have been brought to the market by Kia, Hyundai, Telsa and Nissan. Vehicles which drive longer, charge faster, than the 20 to 30KWh BEV's which were (apart from luxury BEV's like Tesla S/X) the only ones on sale.

- Purchase subsidies and lowering purchase tax are powerful incentives, , but a powerful, large, visible and general policy aimed at advantages of EV's consisting different types of priorities (road use, parking) can play an important role in the accelerated uptake of sales of EV's.
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- Next to the financial incentives there are more boundary conditions which influence the uptake of EV´s. As concluded in earlier studies, local privileges for road access, zero emission zones and for parking/charging advantages, are strong drivers.
- But the overarching conclusion is that independent how good purchase incentives are, their impact very much depends on the BEV availability. The future outlook of new models show a significant growth in affordable vehicle with a sufficient range. In the upcoming 2 years there will be 37 EV models introduced in Europe, which will have a significant impact on the EV sales growth.

7 Discussion

We are aware that the current calculations about the different versions of the VW Golf do not represent all BEV's. The reason of the decision to start with the purchase and TCO comparisons of the Golf, is that these versions are very much alike. To achieve a better representation of the market, we will extend the research to

other vehicles as well, to have a better balanced overview of the effect of incentives on EV sales uptake. We expect to have increased the number of different models so we can include it at the presentation of the EVS32.

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Appendix I: Methodology

Methodology

The analysis of the impact of the incentive schemes on the comparative TCO and purchase price is based on web research about national incentives and the financial structures of car ownership. In addition, for each country an EV expert with knowledge about EV incentives was asked to provide input on car incentives and financial structure of car ownership on national level.

The countries which are currently covered in this analysis are the Netherlands, Germany, Austria, Denmark, Norway, Sweden and United Kingdom. For each country, the private and business TCO and purchase prices were compared between a petrol, diesel and electric version of the Volkswagen Golf, respectively 1.0 TSI 85hp Trendline, 1.6 TDI 115hp Trendline and e-Golf. 1

Purchase cost

The model's purchase cost was calculated by taking into account the list price, obtained from the pricelist on the country's Volkswagen website, VAT, purchase taxes as well as eventual purchase subsidy. Data about vehicle purchase regulations were obtained from the official websites of national authorities.

TCO

The TCO calculations are based on the assumption of driving 15.000 kilometres per year and four years of usage. The total cost of ownership over this period is calculated based on the total depreciation, insurance, vehicle tax, maintenance and total energy costs for owning the particular car in the given country. In order to calculate the depreciation over the total usage period in a specific country, an additional research was performed about second hand electric, diesel and petrol Volkswagen Golf.

For this purpose, firstly, second hand cars were selected from car search engines which show the offer from several used car websites, for instance [7] for The Netherlands or [8] for Germany. Selection criteria included 40.000-80.000 KMs, between 2014 and 2016. Moreover, the cars should be as similar as possible to the 2019 models used for the TCO regarding horsepower, engine capacity and type (e.g Trendline or Comfortline). Secondly, to account for profit and negotiation margins, we estimated the residual value by deducting 8% from the price for which the car was offered. Thirdly, the total purchase price at time of purchase was estimated for each car, including the net catalogue price, purchase taxes and possible subsidies. Data about vehicle purchase regulations were obtained from the official websites of national authorities. The catalogues prices at time of purchase were obtained from official Volkswagen Golf pricelists per country and year, gathered via personal communication or Volkswagen websites. To differentiate between private and business depreciation, purchase price and residual value were calculated including and excluding VAT. Finally, we estimated a car's depreciation percentage for private users by diving the depreciation (total new purchase price minus residual value) by the total new purchase price. All depreciation percentages are estimated for both private and business owners, respectively with and without VAT.

The energy costs over the total usage period were calculated based on the fuel consumption in practice, l/100 km for petrol and diesel, and kWh/100 km for electric, as indicated by TNO and EV Database, respectively. The average price per litre gasoline and petrol per country were obtained from [1]. The average price per kWh per country was calculated based on electricity prices for household and non-household consumers in the last quarter of 2018 [2]. We assumed 50% household and 50% non-household electricity use for both private and business. Finally, the relative TCO difference between owning an electric version versus the diesel and petrol version were calculated per country.

BIK

Since employees must pay tax for the private use of a company car, the benefit-in-kind (BIK) should also be taken into account for in the TCO in case of private use of a company car. The BIK was calculated based on the percentage of income taxation, as indicated on the respective official governmental website. Moreover,

[1] Since the Golf 1.0 TSI 85hp is not available in Sweden and Norway, the 115hp version was included.

the percentage of BIK was either retrieved from the country specific Volkswagen pricelist or from the official governmental website as well.