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Incentives for electric vehicles: A case study of Denmark and Norway

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Abstract

The development of the Danish and Norwegian electric vehicle (EV) markets and deployed policy support mechanisms clearly illustrate the positive correlation among the magnitude of purchase incentives and diffusion of electric vehicles. This paper highlights the repercussions of retracting tax exemptions for EVs by investigating the Danish market diffusion since a progressive taxation scheme taking effect in January 2016 was enacted. In addition to Denmark, the paper evaluates the effects of diverse purchase incentives within the Norwegian EV market, which has reached a new plateau of maturity. The results indicate that financial incentives, with the current technological advances, are required for stimulating EV uptake, as Danish EV sales have plummeted with the introduction of registration tax. However, as the EV market matures, the effects of some policy support mechanisms decrease.

Keywords: EV incentives, Denmark, Norway, effects of incentives

1 Introduction

With the introduction and growing adoption of electric vehicles, the world is facing a paradigm shift within mobility, as the transition to electrified transportation can lead to drastically reduced CO2-emissions [1]. However, the diffusion of electric vehicles is confined to a curtailed amount of countries with Norway representing the best case by far [2]. All these countries share a common feature, namely, the deployment of policy support mechanisms stimulating EV uptake. This acknowledgement indicates that the diffusion of electric vehicles remains dependent on financial incentives, and that purchase incentive levels and EV sales are closely related. This paper will therefore investigate the diffusion of electric vehicles on the Danish and Norwegian EV market, and compare it to the development of their specific deployment incentives.

2 Incentives overview

EV uptake incentives can roughly be divided into three categories including purchase incentives, use/circulation incentives and waivers on access restrictions [2]. The purchase incentives are tax incentices which include registration rebates, purchase tax exemptions, VAT exemptions and tax credits [3]. The use/circulation incentives cover other financial incentives and include e.g. grants, circulation tax exemptions, waivers on parking fees, toll and ferries, electricity price reductions, and tax credits for company cars, whereas waivers on access restrictions include access to bus lanes, HOV lanes and other restricted traffic zones [2] [3]. More widely such incentives may be called convenience incentives since other actions than just waivers on access restrictions may work as incentives, e.g. access to and standards for charging, guidance for buying and using EVs and others. Figure 1 provides examples of incentives

Tax incentives, e.g.	Financial incentives, e.g.	Convenience incentives, e.g.
▪Registration tax exemption ▪Road tax exemption ▪Reduced company car tax	▪Grant for buying EV ▪Toll road exemption ▪Free parking spaces ▪Free public charging	▪Reserved parking spaces ▪Bus lane use ▪Short-range fast charging stations ▪Standards ▪Dedicated guidance

Figure 1. Examples of incentives for promoting electric vehicles.

Among the incentives, recent studies [1] [2] [4] indicate that the most effective means for increasing EV deployment are purchase incentives and waivers on access restrictions. The findings of these studies are supported by [4] and [5], which pinpoint financial incentives as the most effective means for stimulating EV uptake.

3 Case study

As highlighted above, the price of the vehicle and convenience related benefits represent the primary reasons for purchasing an EV. The following section will therefore investigate how the Danish and Norwegian EV markets have reacted to purchase incentives alterations.

3.1 Denmark

The Danish EV market has throughout the past year developed abnormally confirming that tax exemptions represent the primary impetus for EV uptake [6]. This observation is confirmed by a likewise development in The Netherlands, where the sale of PHEVs dropped after declining financial support.

Up until January 2016, EV passenger cars in Denmark were exempted from registration tax, which resulted in a significant price reduction, as these EVs, at that time, were eligible to a premium of up to 150 % in registration tax. However, a new bill taking effect from January 2016 entailed that the registration tax on EVs would increase progressively with 20% each year until 2020 in which all purchase tax exemptions for EVs will be out-phased [6]. The introduction of registration tax had an immediate effect on EV sales, as Q4 2015 saw a massive frontloading of sales to avoid incurring the upcoming 20% purchase tax, followed by a massive sales plunge in 2016 [7]. However, in Q3 and Q4 2016 sales increased, as the progressive registration tax scheme was about to reach 40% as of January 2017 [8]. Then, in 2017, the EV sale came to an almost complete hold when the 40 % of full registration tax was in force. These observations clearly illustrate the repercussions of phasing out EV purchase incentives, and indisputably determines that policy support mechanisms are regulating EV deployment. In the law for normalising the registration tax of EVs there was a possibility to reopen the political settlement behind the law and negotiations took place in spring 2017. Maybe this uncertainty regarding the tax policy also had an effect on the collapsing sale.

The result of the negotiations is, that by 1. July 2017 to 31. December 2018 the 40 % tax is withdrawn with retroactivity to the 20 % of full tax as of 31. December 2016. An extra incentive to the withdrawal is an approx. 230 Euro/kWh battery capacity (up to 45 kWh) deduction in the calculation basis for the tax. In effect, small and medium sized EVs are now in reality tax free. The effect of these new incentives cannot yet be concluded.

The Danish car tax system is rather complicated and is explained in the table below, showing the new tax calculation by 1. July 2017.

Danish tax system for EVs, example				
	Exchange rate DKK to Euro: 0,1345 has been used			
Step		Calculation	2017 40 % befor ease Euro	2017 20 % after ease Euro
1.	List prise excl. tax and VAT		32.280	32.280
2.	VAT	0,25	8.070	8.070
3.	List price excl. tax, incl. VAT		40.350	40.350
4.	Reduction in taxed value due to safety equipment		1.798	1.798
5.	Reduction in taxed value due to battery size up to 45 kWh. 35 kWh used as example	35 x 228,65 Euro	0	8.003
6.	Taxed value	3. - (4. + 5.)	38.552	30.549
7.	Tax of value <14337,7 Euro	105 % x 14337,7 Euro	15.055	15.055
8.	Tax of value >14337,7 Euro	150 % x ((6.) - 14337,7 Euro)	35.246	23.242
9.	Tax before reductions	7. + 8.	50.300	38.296
10.	Reduction in tax due to energy efficiency >16 km/l. 75 km/l petrol equivalent used as example	538 Euro x (75 - 16)	31.742	31.742
11.	Reduction in tax due to safety belt tensioners	80,7 Euro	81	81
12.	Tax in all without benefits	9. - (10. + 11.)	18.478	6.473
13.	Tax incl. benefit	40 % or 20 % x 12.	7.391	2.589
14.	Tax deduction 10.000 DKK Tax deduction 1.345 Euro		1.345	1.345
15.	Tax in all	13. - 14.	6.046	1.244
16.	Sales price of EV in example	3. + 15.	46.396	41.594

Table 1. Danish tax calculation for EVs. The example is representative for e.g. VW e-Golf and BMW i3

Contributing to the falling sales has been reduced awareness of the EV because of a weak interest from the recent government. For example, there is no financing of EV projects at the moment. From 2010 to 2015 several projects to demonstrate and implement EVs existed which were partly publicly funded. Among others a demonstration project of 300 EVs was in force from 2011 - 2014 and 400 carsharing EVs and 400 mini-lease EVs has been co-financed.

3.2 Norway

The Norwegian EV market has throughout the past years developed rapidly with a market share above 25% (BEV and PHEV) of new registrations [2] [7]. However, the Norwegian EV uptake seems to have reached a plateau of maturity with stabilizing sales throughout 2016 [9], see Figure 1.

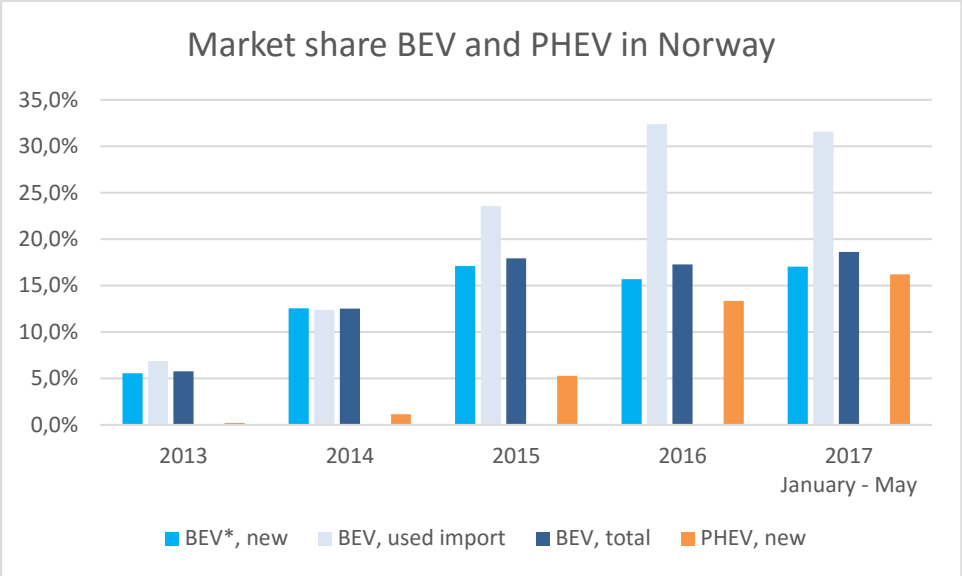

*Figure 1. Development of BEV and PHEV market shares in Norway. *A few FCEV is included in the sales statistics which does not affect the market share.*

This plateau of maturity provides interesting insights into the effects of EV purchase incentives [1]. First, several studies have clarified that the market diffusion of EVs in Norway comes as a result of the magnitude of their purchase incentives [2]. Since the 1990s, Norway has deployed more or less all conceivable EV uptake incentives including registration tax exemptions, free public parking, toll exemptions, bus lane access, reduced ferry rates, and construction of public charging points, which naturally have stimulated EV uptake [2]. However, in recent studies, it was concluded that the benefits of waivers on access restrictions are declining, as EV access to bus lanes has resulted in congestion in those lanes [10] [11].

Other explanations than declining benefits may exist. For example, the market for EVs may at the moment be reaching saturation. This may be caused by the facts that EVs cannot satisfy all users' needs and that a broad range of EV (BEV) models only exists in few segments.

Regarding the users' needs, almost 40 % of passenger cars sold in Norway have four-wheel drive [9] which only Tesla in the executive and SUV segments can offer. Four-wheel drive is attractive outside the larger cities in Norway because of poor rural roads or limited snow clearance. Many PHEV offers four-wheel drive and can therefore satisfy these costumers. For example, Volvo XC90 T8 PHEV has become popular in the SUV (J) segment [9]. The SUV Tesla X was introduced in Q4 2016 and seem to gain almost 20 % market share in this segment [13]. This market share indicates that costumers in this segment who do not choose the Tesla X may have needs that this model cannot offer (more "off-road like", longer range, larger size etc.). It seems like the Tesla X model is "cannibalising" the S model which is however still popular in the Executive segment (Table 2).

Regarding the number of models, a broad range primarily exist in the so-called C segment (medium sized cars like e.g. VW Golf) and have reach a high market share, both in the segment and of BEVs sold, see table

2 [13]. This may support the thesis of saturation. No BEVs exists in the D segment (large cars like e.g. VW Passat), but a few PHEV exists in this segment which may be another explanation of the growing PHEV sale. In the A segment of mini cars only the VW e-Up exists, which has become rather popular, and in the B-segment of small cars only the Renault Zoe is present. These cars are, even with the Norwegian economic incentives, rather expensive compared to conventional cars in these segments – especially the Zoe. A rather large number of used import cars in Norway may satisfy customers who want an EV but cannot effort a new car and who normally would by a conventional A or B segment car because of their low price.

Market shares of passenger cars by segment, %

		2015			2016		
Segment	Designation	All cars of al cars	BEV of BEV	BEV of segment	All cars of al cars	BEV of BEV	BEV of segment
A	Mini	4,0	12,0	51,6	2,5	8,3	51,6
B	Small	11,6	9,7	14,3	11,0	12,4	17,7
C	Medium (Compact)*	32,3	61,6	32,6	32,0	63,6	31,2
D	Large*	18,3	0	0	17,3	0	0
E	Executive	2,8	15,7	96,4	1,4	8,5	93,6
J	SUV	28,8	0	0	32,3	5,9	2,9
	Other	2,1	1,0	14,2	3,6	1,4	14,2

* The Norwegian Compact class seems equal to the EU Medium C class
The Norwegian Medium class and Large class seems equal to the EU Large D class

Table 2. Market shares by segment in Norway [13]. For the D segment, the sum of the Norwegian medium and large segments have been used. The C segment of medium cars is called compact in Norway.

The discussion above shows that the market for BEVs may be further developed, and the recent plateau of maturity overcome, as the range of BEV models increase and the price in especially the A and B segments decrease. As mentioned, the benefits of convenience incentives such as waivers on access restrictions may decline as the numbers of EVs becomes more dominant. Langbroek [11] points out, that people should be moved to a more advanced stage-of-change by increased awareness of EVs and information of e.g. vehicles, travel patterns and charging infrastructure [12]. When people becomes more motivated to buy an EV less policy incentives are needed, but on the other hand financial policy incentives are likely to become less effective in the more advanced stages-of-change [11]. This indicates, which may be a natural consequence as EVs becomes more dominant, that the relative effect of financial and convenience incentives on EV diffusion gradually fades as the market matures.

4 Implications for EV incentives

The above acknowledgements pose serious implications for the deployment of policy support mechanisms stimulating EV uptake. As illustrated on the Danish market, financial incentives are required to convince people that EVs represent a viable alternative to conventional vehicles, since the introduction of registration tax has resulted in dramatically reduced sales [5] [12]. Similarly, Norway is seeing stabilizing EV sales, since

the effects of especially their convenience incentives are gradually declining as the market reaches a new plateau of maturity. It can, hence, be concluded that purchase incentives are required for EV diffusion, as the Danish and Norwegian case studies have confirmed that a large magnitude of incentives equals high EV sales and vice versa. However, as the different incentives may have different effects depending on the maturity of the market, and the specific variables of each individual country, the deployed EV policy support strategy should be chosen wisely [11]. Thus, financial incentives and convenience incentives like e.g. reserved parking and bus-lane driving are needed to stimulate diffusion in the early stages of EVs, whereas the more advanced stages require measures of dedicated information and more convenient ownership and daily operation of EVs like e.g. charging possibilities [11] [12].

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