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Success factors in Electric Vehicle policy: market evolution and EV incentives in selected European countries

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Executive Summary

For over 8 years, FIER is studying and analysing the developments of the different governmental (financial) incentives for stimulating Battery Electric Vehicle (BEV) uptake. In the last couple of years, we focused on the latest developments of incentives on a regular basis and calculated the real effect of incentives on purchase costs, Total Cost of Ownership (TCO) and Benefit in Kind taxation (BiK) of BEVs and compare this to Internal Combustion Engine Vehicles (ICE Vehicles) in multiple European countries. We concluded a positive relationship between these incentives and the uptake of BEV's. In the current study we focus on the difference between some frontrunning countries from Western Europe with a high budget of incentives and some relevant countries from Eastern Europe with a low incentives budget. The aim of this study is to analyse the effect of tax reduction and sales subsidies on BEV uptake in these countries in order to set up the discussion on strategies on EV uptake for countries without high BEV uptake in the last couple of years.

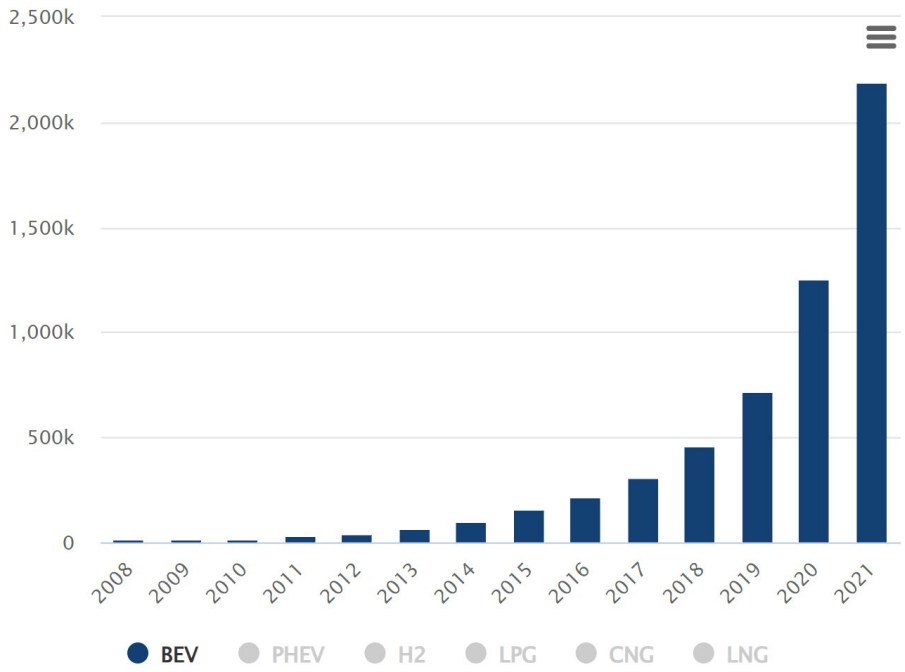
1 Introduction

The European Green Deal calls for a 90% reduction in GHG emissions from transport by 2050, to help the EU become the first climate neutral continent. A sustainable, smart, and resilient European transport system is necessary to support this transition. However, transports remain a key obstacle to achieving the

EU's climate targets, also severely impacted by the still unresolved Coronavirus pandemic. Despite recent efforts, cities of the Central European region are still affected by traffic congestion, high levels of air (CO2 emissions) and noise pollution, and road accidents. Digitalization and novel technologies show significant potentials to help greening future urban mobility and enhancing people's life quality. At the same time, adopting new mobility services enabled by digitalization are also considered an emerging challenge [1].

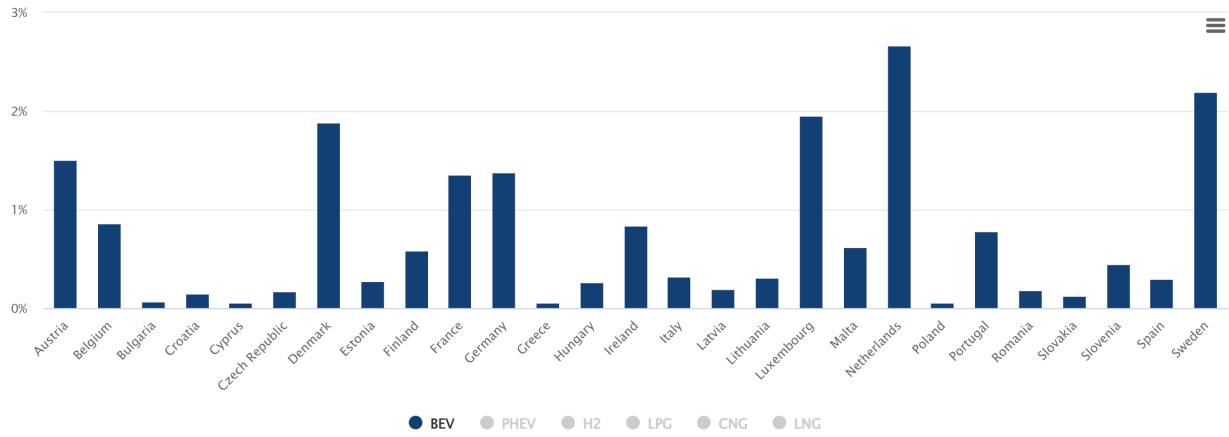
The Green Deal, the 2030 Climate Target Plan and the Sustainable and Smart Mobility Strategy [2] have underlined the need for a rapid take up of zero- and low-emission vehicles to tackle, amid the increased climate ambitions for 2030 and climate neutrality by 2050. The mass deployment of urban electro-mobility systems not only promise significant impact on cancelling air and noise pollution but offer a multitude of systematic energy management capabilities.

Despite severe economic and health effect of the COVID-19 pandemic across the globe, the market evolution of Electric Vehicles (EVs) showed significant growth in Europe with a total of almost 2,2 million BEV on the road within the European Union at the end of 2021 (see figure 1.;).



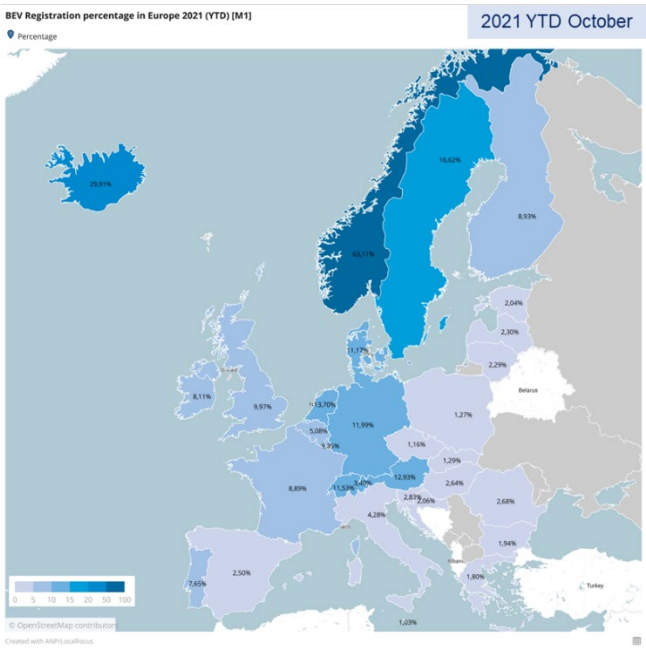
1. Figure: evolution of BEV models in EU countries. Source EAFO (2022)

The new registrations of vehicles with internal combustion engine (ICE) setback with serious rates. The reason for this was the strengthened commitment of government and industry to electric fuelled vehicles in forms of subsidies and supportive polices, and parallelly more stringent conditions for ICE owners. There is however a big difference between European countries in the uptake of BEV's. In the figure 2. below we see fleets in EU-countries such as The Netherlands and Sweden with a BEV-fleet percentage above 3% but many countries with a BEV fleet percentage lower than 0,5% with countries such as Bulgaria and Poland with fleet percentages below 0,1%.



2. Figure: BEV share of total fleet in EU countries.

In the overview of European passenger car fleet's transition to BEV, Norway is the frontrunner within Europe in the uptake of BEVs and ahead of all the EU 27 countries (Figure 3.). In this paper we compare the different countries with each other regarding the EV policy environment and discuss relationships between this environment and the actual BEV uptake within these countries.



3. Figure: BEV Registration percentage in Europe 2021 (YTD October)

In former studies we analysed and concluded that there are 4 main factors that corelated with BEV uptake. These 4 main factors are financial advantage, usability of the BEV's, mindset of the possible customers and availability of the BEV's. In this paper we will focus mainly on the financial factor and the role of the governments within this factor.

2 Overview of supportive environment for EV uptake

2.1 Consumer and policy perspective of influencing factors

From the consumer perspective, the dimensions, which influence purchase decision, and therefore directly affect the new registration on the macro level. The success of BEV sales is determined by various factors

influencing buying behaviour. For governmental organisations it is possible to steer purchase behaviour, mainly by financial policy. We identified four factors that have key influence: (1) Available BEV's – the supply and diversity of vehicles on the market, available to consumers; (2) Financial and economic – the purchase and operational costs of BEVs; (3) Usability of the vehicle; (4) Mindset – how electric drivetrain is attractive for consumers. It is an important aspect, that the general perception of the public on EV attractiveness and government policy is to be aligned.

From the policy perspective, there can be different types of public support for the deployment of electric vehicles on different levels of government. On the high level, policy measures may be classified to four categories: (1) legislation, including regulations, directives, and standards; (2) targets, meaning governmental or international commitments and agreements; ambitions, such as strategies or roadmaps; (4) proposals, meaning tentative government objectives which stimulate discussions and accelerate already published commitments (IEA, 2021). Additional taxonomy of financial incentives is introduced by Yang et al., (2016), differentiating (1) subsidies (income tax credit and vehicle purchase rebate) and tax reductions (one-time vehicle tax reduction and annual vehicle tax reduction).

2.2 EV incentive policy environment in Europe

There are significant differences among EU countries about the uptake of alternative fuel (AF) technologies, particularly electro-mobility. Whereas certain regions have more developed EV markets - i.e., Norway, Germany, France, the Netherlands, other regions such as Southern and Eastern Europe (e.g., V4 countries) countries in a growing phase. This paper focuses on the relation of EV market evolution and government incentives, policies to support EV uptake across Europe, by sampling extreme cases. We sample countries based on the share of BEVs in new registrations, considering cases where values are high (France, Netherlands, Norway, Germany), and low (Czech Republic, Poland, Hungary, and Romania). The research reviews and analyse the EV incentives and policy environment in selected countries, in particular government subsidies during the period of the COVID-19 pandemic. Countries are adopting different incentive measures to support EV uptake. Table 1. provides an overview of these various measures.

	Purchase subsidy	Registration on tax benefits	Ownership tax benefits	Company tax benefits	Vat benefits	Other benefits (e.g., free parking)	Infrastructure benefits
Ireland	✓	✓	✓	✓		✓	✓
Greece	✓	✓	✓	✓		✓	✓
Portugal	✓	✓	✓	✓	✓	✓	
United Kingdom	✓	✓	✓	✓		✓	✓
Austria	✓	✓		✓	✓		✓
Belgium		✓	✓	✓		✓	✓
Spain	✓	✓	✓			✓	✓
Sweden	✓		✓	✓		✓	✓
Germany	✓		✓	✓	✓		✓
Hungary	✓	✓	✓	✓		✓	
France	✓	✓		✓			✓
Cyprus	✓	✓	✓			✓	
Finland	✓	✓	✓				✓
Malta	✓	✓	✓	✓			
Netherlands	✓	✓	✓				✓
Poland	✓	✓				✓	✓
Slovakia	✓	✓	✓			✓	
Czech Republic	✓	✓	✓			✓	
Croatia	✓	✓				✓	
Denmark		✓				✓	✓
Italy	✓		✓				✓

Latvia		✓	✓	✓			
Luxembourg	✓		✓	✓			
Romania	✓	✓	✓				
Slovenia	✓	✓	✓				
Lithuania							✓
Bulgaria			✓				
Estonia	✓						

1. Table: Overview of European countries and key EV incentives (2020) Source: own edition based on EAFO (2021) [1] and ACEA (2021) [3]

Despite doubting statements by industry leaders such as Elon Musk on the role of government subsidies on the support of EV purchases [10], we assume a direct relationship between the total cost of ownership (TCO) difference (delta) of BEVs and ICE vehicles, and the growth of new registrations in European countries. In March 2022, new registrations in Norway reached an all-time high of 86%. As a result of government measures, electric drive system became the number one in the country. As of May 2022, the Norwegian Ministry of Transport considers the reduction and abolish of certain incentives, especially in urban areas. [7] As the price difference can directly be influenced by fiscal financial incentives, it influences the TCO. The scale, how the available purchase subsidies and tax incentives decreases the TCO of BEVs, determines the uptake of EVs in each country. This presumes that the other factors are satisfactory.

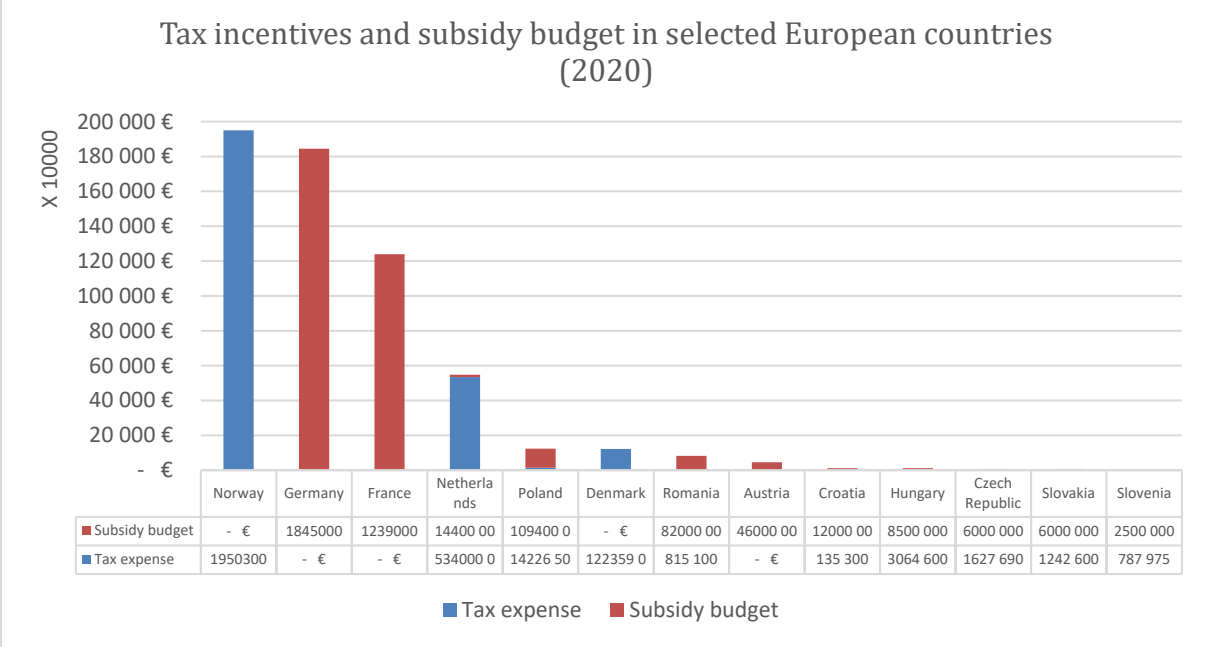
By losing certain complexity of the comprehensiveness of policy mechanisms, EV incentives can be described, using five parameters: (1) incentive type; (2) incentive consumer timing – when the consumer receives the financial benefit during the ownership period -i.e., during purchase, or several months later; (3) incentive eligibility – how strict or flexible is the scope of applicants; (4) incentive program durability – available timeframe; (5) incentive level – available amount per vehicle. Although government subsidies to accelerate new BEV registrations are available in all EU member states now, the examination of 2020 data shows that the design principles, described above, particularly the incentive level, greatly differed across European regions [9].

2.3 Subsidies across Europe

Before the COVID-19 situation, the increase of e-mobility support strategies and policy actions were already observed, including fiscal incentives and stricter CO2 emission standards. Purchase subsidies grew in first half of 2020, especially in Germany, France, and Italy. Consequently, passenger BEV sales in Europe were 55% higher during the first-half of 2020 relative to the same period in 2019. [9]

Purchase subsidy is a popular incentive type in Europe. The effectiveness of purchase subsidies' incentive level is determined by two main factors: the size of the budget and the maximum amount available per vehicle. If the subsidy amount is smaller, it can be distributed among more buyers without having to increase the available limit, so more cars will be purchased. And if the budget is larger, it can be distributed among many applicants for a larger amount and can be used for a longer period. However, as a study in Norway points out, for the most part, these subsidies motivate households with more wealth, usually families. This is a problem because electric cars are only bought as a second car (next to the ICE car). The opposite effect is achieved, because only the vehicle fleet is increasing, and the emissions of electric cars are an additional burden on the environment. For this consideration more and more countries introduce scrapping bonus, where an older ICE vehicle further enhances the maximum available subsidy [4-6].

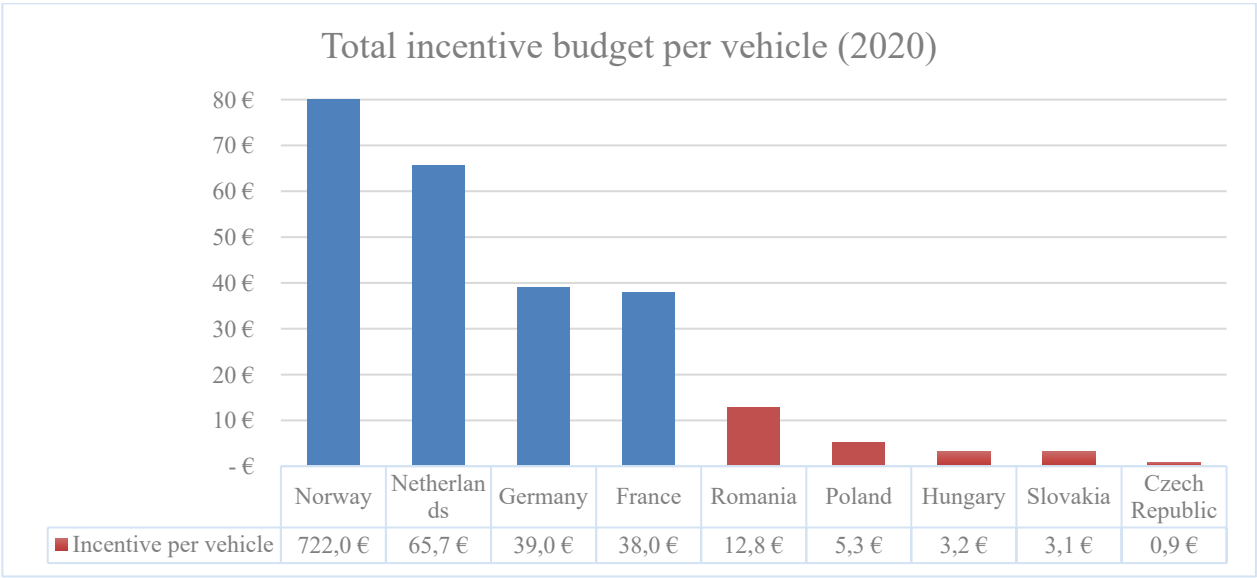
Germany and France kick started their large-scale stimulus package as a response to the COVID-19 crisis, which greatly levelled their commitment close to Norway. In figure 1. we conclude the big differences in total budget of incentives between the front running countries and other countries. The availability of data on the total expense of different incentive types is a limitation of our research.



	Norway	Germany	France	Netherlands	Poland	Denmark	Romania	Austria	Croatia	Hungary	Czech Republic	Slovakia	Slovenia
Subsidy budget	- €	1845000	1239000	14400 00	109400 0	- €	82000 00	46000 00	12000 00	8500 000	6000 000	6000 000	2500 000
Tax expense	1950300	- €	- €	534000 0	14226 50	122359 0	815 100	- €	135 300	3064 600	1627 690	1242 600	787 975

4. Figure: Tax incentives and subsidy budget in selected European countries (2020)

There are two main approaches identifiable among the countries, one where purchase subsidy budget is significant, while another one, where the tax expense budget is significant. There is a significant gap between Western Europe and Eastern-Central European countries from the lens of incentives per vehicles of the whole national fleet.



	Norway	Netherlands	Germany	France	Romania	Poland	Hungary	Slovakia	Czech Republic
Incentive per vehicle	722,0 €	65,7 €	39,0 €	38,0 €	12,8 €	5,3 €	3,2 €	3,1 €	0,9 €

5. Figure: Total available budget per vehicle in selected European countries

While Norway shows an estimated extreme of 722 EUR per vehicle, the Netherlands stands out with 65,7 EUR per vehicle. Germany and France show an interestingly similar value of 39 and 38 EUR respectively. In the developing EV markets, Romania stands out with 12,8 EUR per vehicle, followed by Poland with 5,3 EUR. Hungary and Slovakia have similar values, while Czech Republic lags (0,9 EUR).

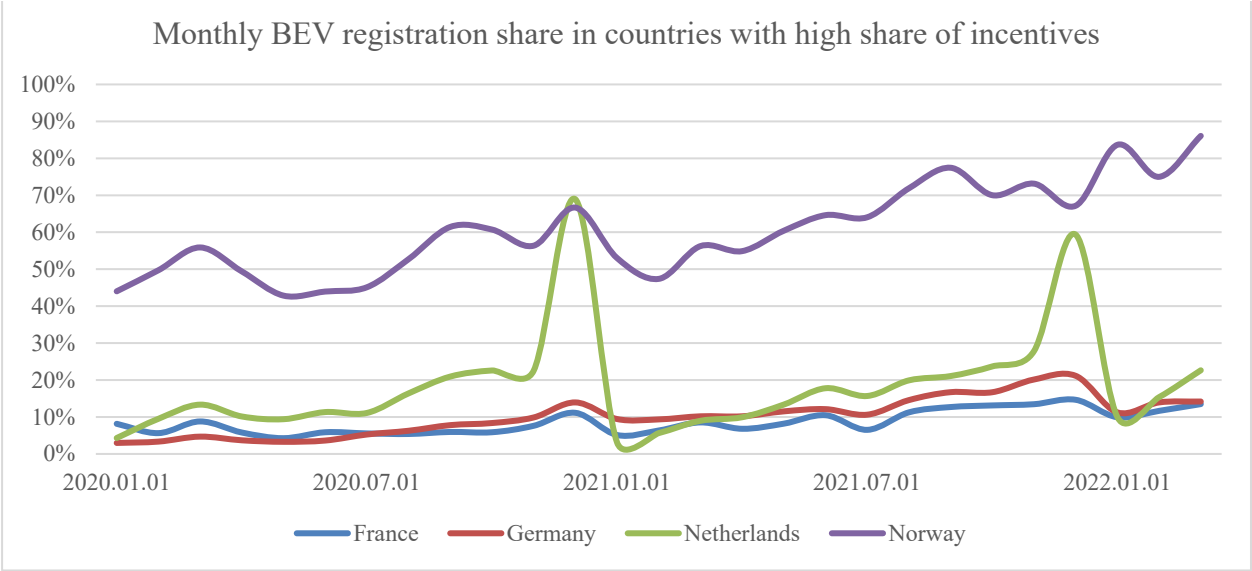
2.4 EV uptake

If we compare the incentives with the EV uptake in these countries from the beginning of 2016 onwards, we can draw conclusions on the success of these incentives. In the figures below we compare the market shares of BEV from the respective countries with a higher incentive level (Norway, Netherlands, France, and Germany) with countries with lower incentive levels (Czech Republic, Poland, Romania, and

Hungary).

6. Figure: Registration percentages of BEVs in frontrunner European countries. Source: European Alternative Fuels Observatory, YTD 2021 (Oct) [1]

Looking at the annual registration percentage of the four outstandingly performing countries, we can observe a steady growth. As the graph withhold 2021 YTD (October) data, the graph is distorted, due to the missing peak sales in the Netherlands.

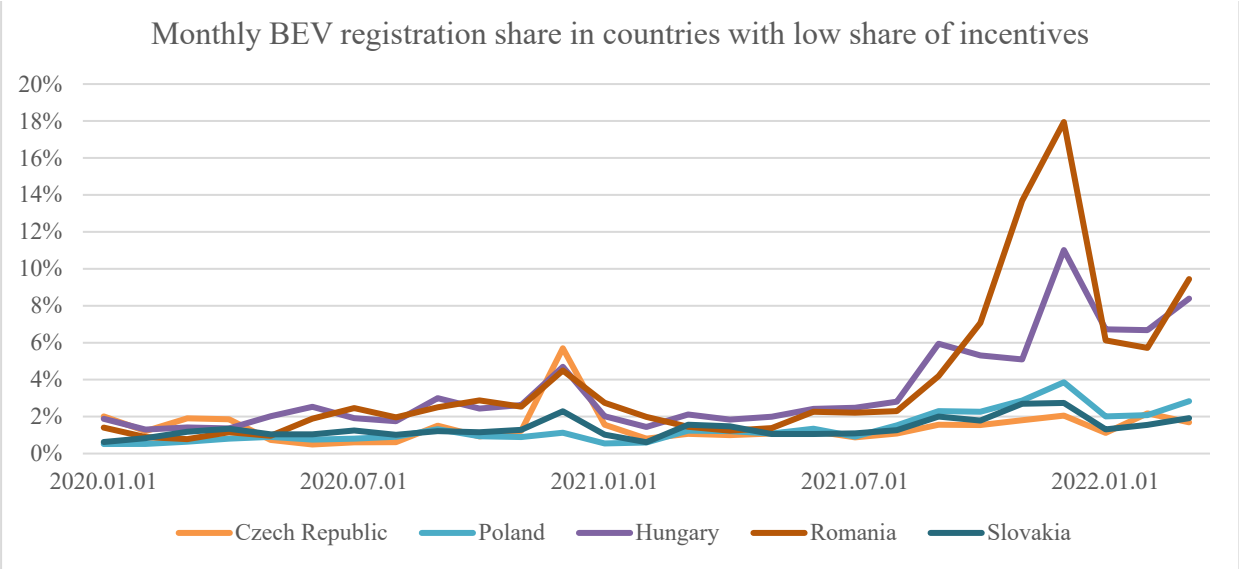


7. Figure: Monthly BEV registrations share in countries with high share of incentives. Source: European Alternative Fuels Observatory, YTD 2022 [1]

The monthly data to March 2022 indicates the seasonal effects of sales, particularly the peaks during end months of the year, which is directly related to the effects of policy actions.

8. Figure: BEV New registration rates in emerging European countries. Source: European Alternative Fuels Observatory (www.eafo.eu), YTD 2021 (Oct) [1]

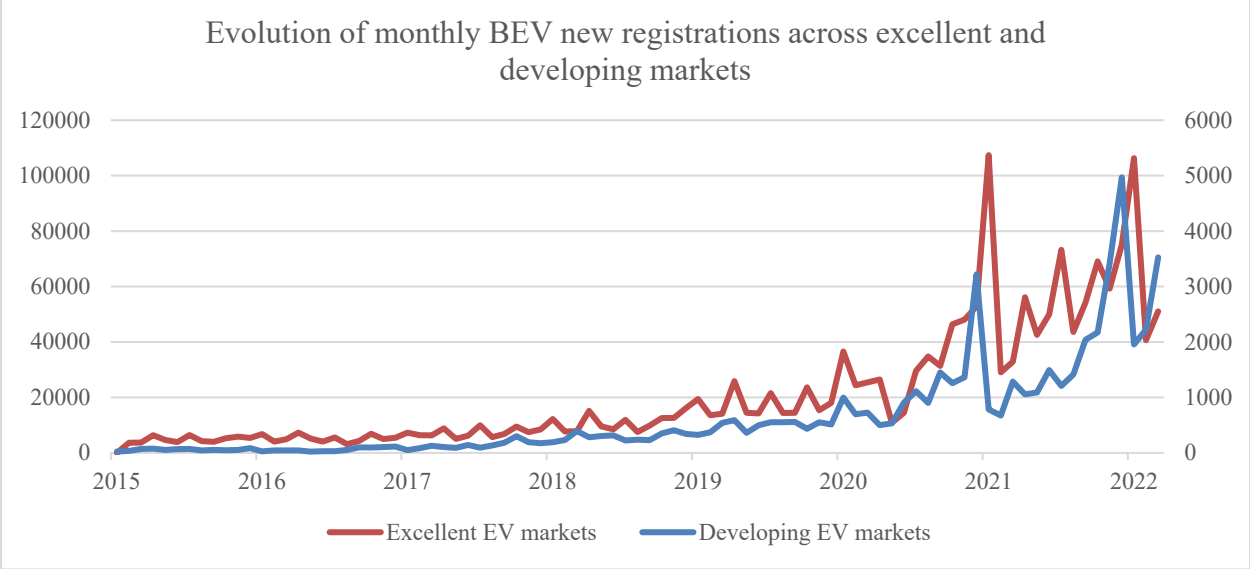
In comparison, the sampled countries in CEE show sharper growth rates, but still low in absolute terms.



9. Figure: Monthly BEV registration share in countries with low incentives

The larger expansion of fiscal stimuli packages in Romania lead to a sharp increase in registration at the end of 2020 and a regional record of 18% at the end of 2021. Despite the rather low volume of incentives in Hungary, and the dissatisfactory management of the application programme, the sales share increased sharply in the second half of 2021.

In the respective figures we conclude that the market shares of the countries with a high budget are currently around and above 10% of total registrations while in the markets with low budget vary between 1,0% and just above 2,5%. The differences in market shares are significant with Norway as exceptional front runner with already a market share of above 60%. In Germany and France, a difference can, be concluded between the years before 2020 and from 2020 onwards when both countries started with significant higher purchase subsidies due to the COVID19 stimulus package.



10. Figure: Evolution of monthly BEV new registrations across excellent and developing markets. Source: European Alternative Fuels Observatory (www.eafo.eu), YTD 2022

Observing the monthly evolution of BEV sales in excellent and developing EV markets, the role of fiscal stimuli is clearly shown. While we see similar trends in growth charts, the scale remains lower for CEE countries.

3 Effects of different incentives

In this chapter, we overview and analyse, how the sampled countries managed their public measures during the observed timeframe. Attention is given to how the different incentives influence the BEV uptake.

3.1 Developed EV markets

Many of the developed EV markets saw increase in the number of BEV registrations due to policies and/or incentives that favoured BEVs. This is well shown in the previous chapter using the uptake data on BEVs derived from EAFO. The amount of incentive per vehicle (in subsidy or tax benefit) is not the most important driver for the BEV uptake, the difference between the BEV and ICE vehicles is. Underneath in figure 11. the purchase price and TCO delta of BEVs and ICE vehicles are displayed. Meaning the price of a BEV and an ICE vehicle are compared. For this calculation the average of the B-, C-, and D segments were used for the business- and private market with a four-year ownership period.

Purchase price	
Poland	-€ 15.576
Germany	-€ 468
Norway	€ 2.939

TCO	
Poland	-€ 4.926
Germany	€ 5.145
Norway	€ 12.921

11. Figure: Delta between ICE vehicles and BEVs on purchase price and TCO in Poland, Germany, and Norway

Both the price difference and the TCO difference is significant, and the uptake numbers are in the same order, Poland has out of these three the lowest uptake numbers and Norway the highest. The conclusion is that the TCO and purchase price have a determining factor in the uptake of BEVs and incentives and

governmental policies have a big influence on the TCO and purchase price. There are, however, big differences within countries and between different ways of incentivizing. Germany and Norway both highly incentivize the purchase of BEVs, Germany via high purchase subsidies and Norway via high taxes on ICE vehicles and low taxes on BEVs. This is largely driven by the tax system in place. Germany has relatively low taxes on cars, therefore, must turn to purchase subsidies to incentivize the purchase of BEVs and Norway has a system with high taxes for cars and high VAT that can be deducted on BEV's. The significant role the automotive industry also affects the choice of these countries in taking the approach of purchase subsidies with the fiscal stimuli.

The pictures below show more detailed the purchase price and TCO calculations of Germany and Norway for 2021. The numbers are the delta, of difference, between BEVs and ICE vehicles in the respective country, segment, and market.

Purchase price	*Business*			*Private*		
	B segment	C segment	D segment	B segment	C segment	D segment
Germany	-€ 1.488	€ 2.486	€ 151	-€ 3.690	€ 1.248	-€ 1.513
Norway	-€ 6.852	-€ 1.081	€ 7.039	-€ 1.919	€ 5.083	€ 15.366

TCO	*Business*			*Private*		
	B segment	C segment	D segment	B segment	C segment	D segment
Germany	€ 6.158	€ 8.810	€ 5.963	€ 2.493	€ 5.232	€ 2.211
Norway	€ 9.651	€ 10.405	€ 18.259	€ 8.517	€ 11.039	€ 19.657

12. Figure: Purchase price and TCO differences in Germany and Norway

Because Norway gives tax benefits on BEVs, the relative benefit of a BEV to an ICE vehicle increases as the cars get bigger. The taxes are determined by, amongst others, weight, and CO_2 emission. Larger cars from the D segment usually are heavier and more polluting per kilometre than cars in the B segment. On the other hand, countries such as Germany that incentivize BEV sales through subsidies, can regulate more specifically which vehicles are supported. Germany has caps on the maximum purchase price of the purchase subsidy which limits the subsidies to (mostly) the A-, B-, and C segment.

Figure 13. shows that Norway subsidizes larger car segments relatively more than smaller segments. Of the total cars sold of the 5 bestselling BEVs over 2021, all vehicles in Norway were from the D segment while in Germany there were more cars sold from the smaller segments.

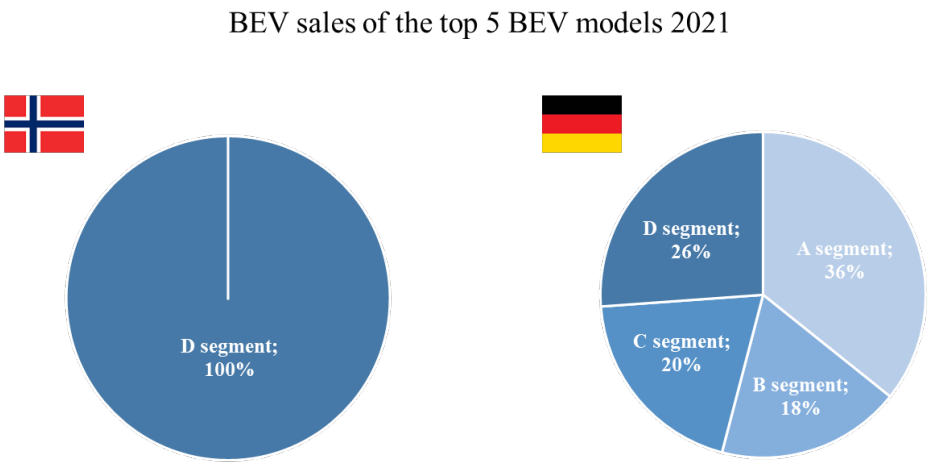
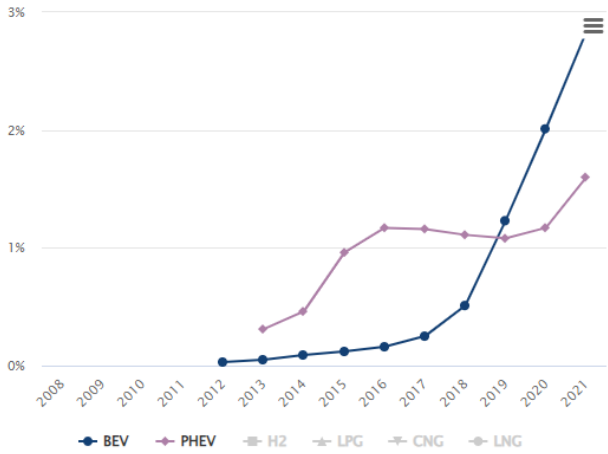


Figure 13: Total sold BEVs of the top 5 BEV models per segment

3.2 Developing EV markets

In the developing EV markets, incentives are not yet as impactful as in the more developed EV markets. This has the benefit that the lessons learned can directly be implemented without having to go through the learning phase. A good example of a lesson learned is the PHEV increase in the Netherlands. From 2012 on the Dutch government has ben incentivizing the uptake of EVs, which was not fully intentional in the beginning of the promotion of EV's (2012 – 2016). The Dutch government changed their incentives on BiK towards only BEV's which resulted in a high uptake of BEV's and no unintended uptake of PHEV's (2017 – 2019). In 2019 the incentives difference between PHEV's and BEV's got smaller since BiK benefits for BEV's got smaller. We see a raise of PHEV's coming back due to progressive CO2 purchase tax which benefits them to diesel and petrol cars.

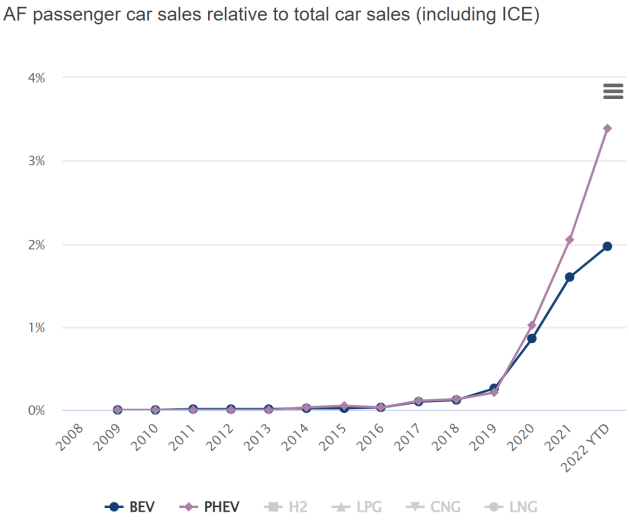


14. Figure: Dutch market shares of BEV and PHEV (Source EAFO, 2022)

In the developing EV markets of Poland and Hungary, we see different incentives. In Hungary and Poland, the policy environment focused mostly on purchase incentives, and the exemption of relatively smaller tax burdens such as vehicle tax, property tax or registration tax. Other non-financial incentives include free parking (HU) or usage of bus lane (PL). The Hungarian government opened a new round of purchase subsidies in 2020 and 2021, with an annual limit of 8,5 million EUR, of which a large share (40%) was dedicated for taxi companies. The eligibility conditions only allowed the purchase of BEVs, which is clearly reflected upon the significant increase of BEV sales from 2021, surpassing PHEV sales, which dominated in the past years (Figure 15.).

15. Figure: Hungarian market new registrations of BEV and PHEV (Source EAFO, 2022)

In Figure 15. and 16., there are differences between Poland and Hungary in the uptake of EV's. Hungary has a relative higher total market share of EV's (11%) than Poland (5,5%) and in Hungary the market share of BEV's is higher than PHEV's while in Poland it is opposite. In the former paragraph we concluded that the total budget per vehicle to stimulate EVs is higher in Poland than in Hungary.



16. Figure: Poland market shares BEV and PHEV (source EAFO, 2022)

The reason for this, is that Poland introduced large scale incentives, with high levels, durability of these programmes is still low, as they entered pilot periods in 2021. November 2021, Poland's state-owned National Fund for Environmental Protection and Water Management allocated 500 million zlotys ($125 million, €115 million) to EV purchase subsidies. As a result, demand grew significantly, 60% of Polish corporate car fleet operators are interested in buying EVs over the next two to three years. Similarly, to Hungary, the programme is already running into capacity issues, where consumers experience long administrative process [11]. The integrity of the Hungarian programme on the other hand gave more reliability to the consumers, despite challenges with the application process. In Hungary, incentives are depleted very quickly (couple of hours), which is not beneficial for the market, because purchases are withhold and trust in the policy environment is lowered. Same effect is seen in the Netherlands in 2020 and 2021. People hold their order to get a chance at the subsidy.

	Business			Private		
	B segment	C segment	D segment	B segment	C segment	D segment
Hungary	-€ 9 887	-€ 4 335	-€ 20 796	-€ 15 027	-€ 7 585	-€ 27 428
Romania	-€ 4 678	€ 849	-€ 23 084	-€ 10 944	-€ 1 184	-€ 29 664
Poland	-€ 11 803	-€ 3 587	-€ 27 110	-€ 17 707	-€ 7 601	-€ 36 534

2. Table: Purchase price differences in Hungary, Romania, and Poland

Looking at the purchase price differences in the observed countries, particularly in the B and D segments, available electric vehicles have a significantly higher purchase price.

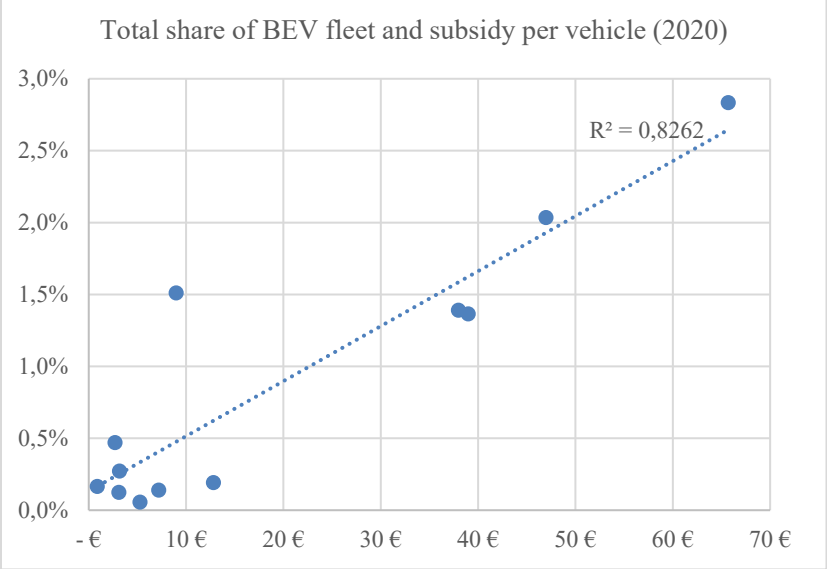
	Business			Private		
	B segment	C segment	D segment	B segment	C segment	D segment
Hungary	€ 1 518	€ 4 351	-€ 11 001	-€ 4 357	-€ 849	-€ 18 267
Romania	€ 4 412	€ 10 530	-€ 370	-€ 3 373	€ 5 283	-€ 16 484
Poland	-€ 1 249	€ 6 350	-€ 10 827	-€ 7 840	€ 351	-€ 20 655

3. Table: TCO differences in Hungary, Romania, and Poland

The differences in TCO shows a much more balanced picture, particularly in the business segment, where higher tax benefits can be achieved. Overall, the delta value is significantly lower in developing EV markets, in contrast to developed ones. The supportive fiscal policies may lower this gap. However, it is restricted by budgetary constraints, especially in Hungary. The rapid depletion of funds presumes, that demand for the subsidy programme surpassed the available financial sources. As these calculations consider home recharging mostly, differences might even be higher in case of public recharging at fast or ultrafast segments.

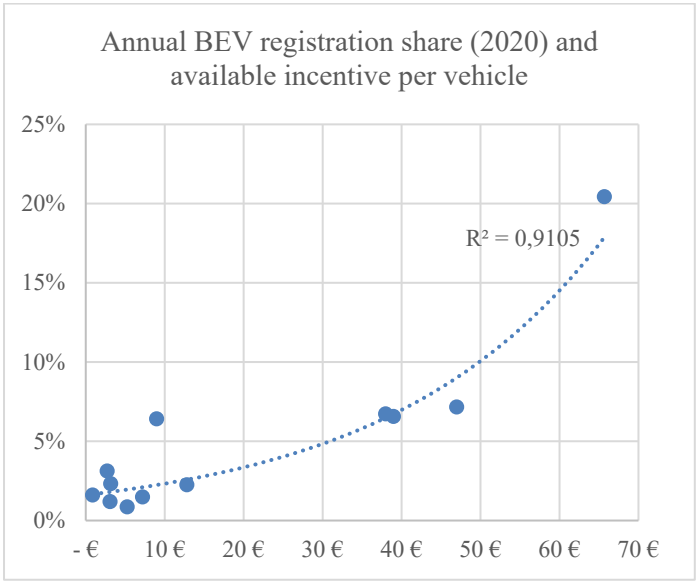
4 Discussion

In this research, we draw first conclusions on the success of high incentives for realizing uptake of BEV's. The discussion we raise is that financial incentives are not the only factor for success, but the most important factor as it relates directly to a lower TCO for the owner. In former studies we concluded that EV uptake is also related to non-financial factors such as availability of recharging infrastructure, the mix of available EV models and socio-economic factors within a country or region. We conclude that the strategy for a country towards a higher EV uptake is directly related to incentives package including financial and non-financial stimuli. Our first implication suggests that the committed amount of subsidy per vehicle of the national fleet is associated with the total share of EVs in a county.



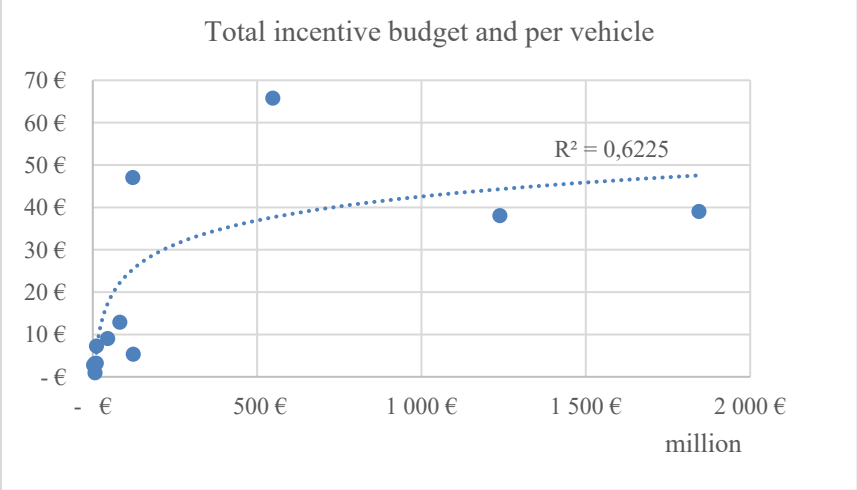
17. Figure: Total share of BEV fleet and subsidy per vehicle (2020)

The total share of the BEV fleet and available subsidy per vehicle show a linear correlation between each other. This remains an assumption due to the limited number of cases sampled. Nevertheless, this is a clear direction for future research to expand the scope of sampled countries, and add qualitative (e.g., ease of purchase subsidy applications) and quantitative data points (e.g., purchasing power).



18. Figure: Annual BEV registration share (2020) and available incentive per vehicle

Even when observing the relation between incentive per vehicle and annual registration (2020) rate of BEVs, the exponential correlation is even stronger. This suggests that the countries where the financial stimuli per vehicle is higher, the TCO difference between ICE and EVs are lower. Therefore, suggesting a pivotal influence on consumer's decision making.



19. Figure: Total incentive budget and per vehicle

The relationship between budget size and share per vehicle shows a logarithmic association, in which case no significant association can be grounded with our existing dataset. Most of the sampled countries focused on adopting purchase incentives by fiscal stimuli. This became a popular measure in lowering TCO differences in both developed and developing EV markets.

We draw the conclusion, that the TCO differences play a pivotal role in EV uptake in both types of markets, on the other hand, measures to diminish differences are not only available by strong fiscal stimuli, (subsidizing), but also by increasing the tax burden on ICE vehicles. The target value of a TCO difference, which is aligned with the desired transition of national fleets can be predicted. At the same time, the policy measure, that public authorities take, on how to lower differences and therefore stimulate EV uptake is a political question. In certain countries, where social acceptance of EVs is lower, the higher taxation of ICE vehicles is an unpopular policy decision. So, subsidizing expensive EVs with financial and non-financial incentives, may trigger disapproval from ICE owners. In those cases, the "mindset" factor restricts the scope of actions of policy makers, who can only resort to smaller scale, representative support programmes.

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Presenter Biography

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