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Painting the EV incentive landscape – a review and visualization of how EV incentives are affecting EV uptake

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Executive Summary

The transition to electric mobility is in full swing. Governments, at local, national and transnational levels are aiming to support and encourage this transition by applying a plethora of incentives, subsidies and other policy measures. This work reviews the current state-of-the-art and practice of these incentives through an extensive analysis of reported policy applications and effectiveness. 17 publications were reviewed that report an evaluation of in total 53 incentives. As a next step, these incentives are linked to a first version of a relational model of factors influencing EV uptake. Combining incentives and EV uptake factors into one single overview supports policy makers and other stakeholders in assessing the applicability, desirability and effectiveness of potential future incentives and increases understanding of the electric mobility eco-system.

1 Introduction

Electric mobility is increasingly becoming more mainstream as markets shares grow and more types of electric vehicles are available [1]. More and more sources are reporting that electric vehicles (EVs) already are, or in the near future will be, more cost-effective than their conventional fuel counterparts [1]–[3]. However, these sources also show that the electric mobility eco-system still is heavily facilitated by subsidies and incentives that aim to support the cost-effectiveness of EVs, develop the EV-infrastructure and stimulate further developments and breakthroughs in EV technology. In [4], further purposes of incentives are described as compensation of the risk of adopting a technology at an early stage of development, fast development towards a critical market to lower costs and finally, for new user groups to become familiar with the technology.

In this research, we present an in-depth review of incentives targeting EV uptake, mainly concerning Battery Electric Vehicles (BEVs) and Plug-In Hybrid Electric Vehicles (PHEVs). The analysis focuses on the evaluation of the effectiveness of these incentives, whereas the discussion highlights several considerations for effective policy application. This research is situated within the proEME project [5], which focuses on supporting stakeholders across the electric mobility eco-system with relevant knowledge and tools to be able to effectively understand, steer and promote electric mobility.

1.1 Goal and research questions

The goal of this research is to provide a broad foundation for future research and dissemination activities in the proEME project [5] by performing an in-depth analysis of the state of the art on evaluation of effectiveness of incentives. Our research considers both the methods that are employed, as well as the outcomes of the evaluations. To frame our research, we pose the following research questions:

1. Which methods are currently used to evaluate incentives targeting EV uptake?
2. What are the outcomes of these evaluations?
3. How can the impact of incentives on the EV ecosystem be captured and communicated?

The rest of this work is structured as follows. Section 2 details the methodology and choices made in the analysis of the state of the art and the subsequent steps. Section 3 gives an overview of the results of the analysis of the state of the art, whereas section 4 maps these results in an EV uptake model. Section 5 provides several conclusions and an outlook on future research.

2 Methodology

This section describes the methodology used to approach the two main items of this research, namely the analysis of EV incentives and the mapping of those incentives on an EV uptake model.

2.1 EV Incentives

This state-of-the-art research focuses on the evaluation of applied EV incentives on the European market with respect to outcomes, as this is more valuable for the project this research is situated in [5]. However, due to the fact that identification of incentive analysis methods is a main research objective, a world-wide scope was chosen. Furthermore, passenger cars (be it BEVs or PHEVs) were the main subject of analysis, as these are most reported on currently. In future research, it could be a goal to conduct more detailed research towards incentives in (current) niche EV markets in the European context, such as e-trucks and e-buses. The literature review comprised scientific literature, reports of public authorities, project outcomes and reports of market parties such as consultancies, using a combination of the key search words “EV”, “electric vehicles”, “incentives”, “subsidies”, “evaluation” and “effectiveness” as well as literature overviews presented in several of the sources identified in the first round of searches. It must be noted that ample literature sources were identified that generically discuss the application of incentives or for example assess the consequences of incentives on Total Cost of Ownership (TCO) for various situations. However, these sources were not included as we aimed to specifically identify evaluations of the effectiveness of incentive applications. An example of this is [2], where purely the impact of incentives on total cost of ownership (TCO) is investigated and evidence on uptake is lacking.

All publications were classified on the aspects detailed in Table 1. This paragraph offers a rationale for the chosen classifications. First of all, in literature, various taxonomies of incentives are given. For example in [6]–[8]. Classifications listed are for example regulatory (imposing restrictions on the market), suasive (used to persuade buyers), procurement (aim to push demand by enabling scale economies) and several more categories. As no clear consensus was found (which is not necessarily needed), we have established the classification shown in Table 1 that suited the rest of our taxonomy of incentives evaluation. Sources were also classified with respect to their applied evaluation method(s), as well as the type and period of data used. For brevity, this work only reports on the applied evaluation method. The classification of evaluation methods has been established retroactively to fit the identified evaluation methods. Three evaluation methods find their basis in quantitative evidence, whereas the qualitative assessments is, as the name implies, more qualitative.

2.2 Relational Model for EV Uptake

The second part of this research involves the development of a relational model for EV uptake to visualize the impact of incentives on the EV-ecosystem. The development of this model builds upon examples as presented in [9]–[11]. Bonnema et al. [9] present an influence diagram as well as a causal loop diagram, both relating several factors influencing EV uptake. Pfaffenbichler et al. [10] use the same type of causal loop

Table 1: Classification for research publications evaluating application of incentives

Aspect	Considerations, Criteria & Categories
Title, Author, Year	Basic information on publication
Geographical Scope	Scope of incentive application – specification of countries as well as region and city where applicable
Description of incentives	A description of the discussed incentives, as phrased by the source

Incentive Type	A classification of the discussed incentive, based on our classification.
	• Financial, with a distinction (if specified) for One-Time or Recurring
	  o One-Time: Financial incentives that affect the vehicle once
	  o Recurring: Periodical financial incentives during ownership
	• Convenience
	  o Non-monetary incentives that increase ease-of-use or value of EVs
	• Infrastructural
	  o Incentives affecting EV infrastructure, notably the charging infrastructure
	• Regulatory
	  o Policies that steer or stimulate the EV market, e.g. ICE bans or public procurement regulations
	• Development (note: no sources are included for evaluation of this type of incentive)
	  o Incentives that support EV technology development, e.g. end of life battery applications, EV technology R&D subsidies

Evaluation Strategy	A classification of the evaluation strategy for the discussed incentive(s), based on our classification, being either
	• Cross-Sectional Regression Model
	  o Cross-Comparison of data including socio-demographics, sales figures, economic data to infer trends across mostly geographic regions
	• Discrete Choice Model
	  o Models based on stated or revealed preference user surveys to identify user preferences as well as the weight of their preferences
	• Scenario Based Predictive Model
	  o Explorative models using basic calculations or more advanced approaches such as agent-based modelling based on various data sources
	• Qualitative Assessment
	  o Expert based assessments based on available data and experiences

Main Outcomes	A summary of the main outcomes of the evaluation

diagrams and translate this diagram into a System Dynamics model using a multinomial logit model for underlying calculations. In essence, the creation of a relational model is a mainly qualitative approach in which concepts are identified up to a certain abstraction level and related using a specific assessment. This assessment can include an indication of the directionality of the relation, whether it is a positive or negative impact, whether the effect is direct or delayed and finally an assessment of the influence strength can also be given. In System Dynamics [12], a next step would be to quantify the relations more explicitly in order to be able to simulate the model. However, at this stage of our research, the objective for the model is to visualize where incentives impact the EV landscape. Therefore, concepts and abstractions are chosen such that the incentives can clearly be related to specific concepts and an "influence path" towards EV uptake can be visualized.

3 EV Incentives Analysis

In this section, a review of EV incentives is given. The review focuses on four goals. These are (1) to identify and classify existing or future EV incentives, (2) to identify methods used to evaluate EV uptake incentives, (3) to understand the effectiveness of EV incentives and finally, (4) to provide an overview of criticisms and possible future directions for EV incentives.

Table 2: Summary of literature review (fully presented in Table 3)

Method	Results
Total number of sources included in the analysis	17
Total number of incentives evaluated in sources	53
Of which: Financial	30
Of which: Financial (Recurring)	13
Of which: Financial (One-Time)	10
Of which: Convenience	14
Of which: Infrastructural	7
Of which: Regulatory	2
Total number of applied methods *(if a paper applied two types of methods, these are both counted)*	19
Of which: Discrete Choice Models	4
Of which: Cross Sectional Regression Models	8
Of which: Scenario Based Predictive Models	1
Of which: Qualitative Assessments	6

3.1 Effectiveness Evaluation Methods

The review of incentives and evaluation of how they are applied has led to several insights which are discussed in this section. As a first step, a quantified analysis of the results is provided in Table 2, whereas Table 3 contains the actual results. 17 publications were included in our review as they reported an evaluation of incentives. Within the results, a wide geographic scope is covered. Several publications conduct a world-wide comparison of selected countries, whereas main countries of focus for literature are currently Norway as well as USA, China and other specific European countries. A wide range of incentives was found, of which several are only applied in a single or few countries, such as a rescission on purchase restrictions for electric vehicles in China.

Several analysis approaches were identified in the reviewed papers. The main ones will be discussed here. We consider an evaluation strategy to be a combination of the type of data collected as well as the way this data is evaluated. In [6], the effectiveness of a policy measure is described as "the number of EVs sold with a specific policy incentive n_1 and the number of EVs sold without that specific policy incentive n_0". For our review, the consequences is that sources were excluded when their results cannot be matched to define a number of EVs sold with or without the incentive. The efficiency of a policy measure is described in [13] by multiplying the cost of the policy measure per sold car with the number of sold cars (n_1), and dividing this by the number of additional sold cars (n_1-n_0). In this work, we have limited the scope towards effectiveness evaluations, and not efficiency evaluations.

The two main types of qualitative analyses that were distinguished in literature are: (1) the incentive is evaluated in isolation, often in a theoretical upfront situation, by for example conducting a (stated preference) survey under the target group, or (2) a number of data points are collected including incentive characteristics and sales outcomes that are compared using mainly cross-sectional regression models. If scenario based predictive models are used, then they often will use various data sources. In our view to model consumer behaviour appropriately, a data source based on either a discrete choice model or cross sectional regression model is needed. We also identified a fourth approach, expert opinions. In our view, this type of evaluation only has merit if a very balanced review is executed across a heterogeneous group of experts to control for the many biases in qualitative evaluations. Its outcomes should be interpreted with even greater care than outcomes of the quantitative evaluation methods.

3.2 Incentive Evaluation Outcomes

This research mainly focuses on incentive effectiveness evaluation methods, but the sources also provide relevant outcomes from the evaluations. From these outcomes, two main trends were identified, that is the importance of one-time subsidies at time of purchase and the context sensitivity of several other incentives.

First of all, it is for example consistently shown that consumers focus on purchase price over use costs [8], [14]–[16] which has clear implications for financial incentives. For example, it is stated in [14] that

consumers focus on purchase price over use costs and also identified that a high purchase price is the strongest barrier toward EV purchase [14]. [17] finds that waivers on purchase taxes are over three times more effective on sales than income tax credits. However, depending on local factors, also recurring financial incentives can be a deciding factor as road tolling exemptions are in some cases the main deciding factor for BEVs in localities with extensive tolling schemes [7]. Secondly, not only financial incentives can be context sensitive, but especially convenience incentives are very context sensitive, e.g. as discussed in [18]. That is also evidenced by the fact that for example bus lane exemptions are in some cases the main deciding factor for BEVs in localities adjacent to a large city with high congestion [7].

As a closing remark, several sources (e.g. [19], [20]) provide an analysis in which the basic monetary value of financial incentives is analysed versus uptake without taking into account TCO. In light of this review we should advocate that presenting such overviews should be regarded as counterproductive because they support incorrect perceptions, even taking into account that for example [19] also presents an analysis including TCO in their work.

4 EV Uptake Model

This section links the found incentives to a relational model of factors influencing EV uptake. The aim is to provide overview and understanding for policy makers and other stakeholders of where and how incentives are ultimately targeting EV uptake.

4.1 Model Development

The model has been constructed so that relevant factors influencing EV uptake are incorporated. These factors are detailed to an abstraction level relevant to fit the described incentives. The incentives themselves are of course also factors that (supposedly) influence EV uptake. In the model, colours are used to distinguish various types of factors. Yellow elements are non-incentives and each incentive group (financial, infrastructural, regulatory & convenience) has a separate colour. Relationships are currently denoted with a +, - or ?. This means that if a source factor increases, the target factor will increase (+) or decrease (-). If we are currently unsure of a relation a question mark is used. Assessment of the relations is done qualitatively by the authors, based on the research presented in this work and is meant as an illustrative example at this point. In order to populate the model, a basis was sought from several sources [14], [21]. Furthermore, a decision was made to clearly distinguish between different types of purchase, being through consumers and through businesses. The resulting model is shown in Figure 1.

4.2 Using the Relational Model

This section aims to provide insight in how a relational model can be used. A relational model can be a key asset in a design process. It is especially useful in a group setting to build a frame of reference between participants in design (or evaluation) discussions, and ultimately can support a systems thinking approach to discover otherwise hidden interdependencies.

This relational model presented in Figure 1 allows us to reason more explicitly on impact of incentives. As an example, it can be seen in the model that a “purchase tax reduction incentive” reduces the “purchase tax” which in turn reduces the “purchase cost”. The “purchase cost” is actually determined by the “vehicle list price”, which in turn contributes to the “OEM/dealer profit”. Having these relations visible prompted the question whether there might be a relation between “OEM/dealer profit” and a “purchase tax reduction incentive”. Therefore this effect was explicitly modelled. This particular observation was also discussed in [13], [22]. The example illustrates that making these factors visible supports reasoning about these kind of side effects. Another example of a side effect is given in [13] as the fact that free parking might increase the relative attractiveness of the car over alternative travel modes (this is not featured in the relational model).

Furthermore, the model also allows the creator(s) to emphasize certain aspects. In Figure 1, it was chosen to highlight the influence of company car purchases on EV uptake. This is important, because when considering for example the Netherlands, the largest share of new cars comes into the market via companies. In fact, this is a general criticism of the research reviewed in Table 3 as well as non-listed sources, as EV uptake research in general focuses itself too much on consumer decisions and too little on the influence of company decisions in the EV uptake process.

Table 3: EV Incentive Evaluation Review - This table present the outcomes of the review on incentive evaluation. Evaluation Method: CSRM (Cross-Sectional Regression Model), SBPM (Scenario Based Predictive Model), DCM (Discrete Choice Model), QA (Qualitative assessment)

Ref, Author(s) (Year)	Region	Method	Description of Incentive(s)	Type of Incentive	Main Outcomes
[7] - Bjerkan et al. (2016)	Norway	QA	Ex. purchase tax (%)	Financial (One-Time)	Norwegian BEV owners particularly emphasize the significance of incentives for reducing purchase costs: exemption from VAT and purchase taxes as a critical incentive
			Ex. value added tax.		
		CSRM	Reduced Fixed Costs	Financial (Recurring)	The model, although it has low explanatory power, shows that responding to RFC incentives is more likely among men, respondents above 45 years of age, Tesla owners and respondents having bought their BEV within the last year. Further, the primary target group of such incentives lives outside the city of Oslo and its neighbouring communities. Interestingly, income levels do not significantly predict belonging to this target group, suggesting that these incentives are important in increasing BEV adoption in all income groups
			Reduce Use Costs	Financial (Recurring)	The model, although it has low explanatory power, shows that incentives which reduce use costs (RUC) are more likely to influence respondents with a college/university degree, lower income groups and respondents living in or near the city of Trondheim
			Priority Incentives (bus lane access)	Convenience	The model, although it has low explanatory power, shows that responding to priority incentives (access to bus lanes) is more likely in respondents with an elementary education and respondents living in neighbouring communities to Oslo. Conversely, less probable target groups are men, respondents above 45 years of age, respondents with low incomes, Tesla owners and respondents having bought their BEV within the last year
[18] - Figenbaum et. al (2013)	Norway	QA	Ex. from VAT	Financial (One-Time)	Seen as Very Important - EV's are more expensive to produce than traditional vehicles causing VAT to be higher
			Ex. registration tax		Seen as Important - The exemption of registration tax on these competing vehicles makes the EV's more competitive.
			Free public parking	Financial (Recurring)	Seen as Important - Effective where parking space is limited. Limited places are available and many have a time limit. Little influence on the total number of EV's unless parking spaces are converted to EV parking on a larger scale.
			Toll exemptions		Seen as Very Important - This measure has a large impact when the toll roads are expensive. Can exceed 2 500 €/year
			Reduced imposed taxable benefit on company cars		Seen as Not Important - This incentive had little impact up to 2012 but might be more important from 2013 for the sales of Tesla Model S. This should be an attractive company car, given its long range and the free of charge supercharger network put in place by Tesla in Norway
			Reduce annual vehicle license fee		Seen as Important - Three rates apply for private cars. EV's and hydrogen vehicles have the lowest rate of 52 € (2013-figures). Conventional vehicle rates: 360-420 €.
			Reduced ferry rates		Seen as Not Important - Not important up till o now, few use it and the value of the incentive is limited
			Bus lane access	Convenience	Seen as Very Important - Very efficient in regions with large rush-hour delays in the traffic. The disadvantage is that only a limited number of vehicles can use the bus lane before buses are delayed.
			Financial Support for Charging Stations	Infrastruct.	Seen as Important - Reduce the economic risk for investors establishing charging stations, and the range issue for EV owners is alleviated as they can charge the vehicles during a longer trip. Increase visibility to the population
			Fast charge stations	Infrastruct.	Seen as Important - Fast charging increases the EV miles driven and the total EV market. It becomes easier for fleets to use EV's and is a premise for using EV's as Taxis
			Reserved number plates	Infrastruct.	Seen as Important - Increases visibility and makes other incentives easier to control, i.e. free parking, exemption from toll road charges
[17] - Gallagher et al. (2011)	USA	CSRM	Sales Tax Waiver	Financial (One-Time)	Large correlation to PHEV sales
			Income Tax Credit	Financial (One-Time)	Small correlation to PHEV sales
			Access to HOV lanes	Convenience	Inconsistent evidence that consumers respond to single-occupancy HOV access

Table 3 - continued: EV Incentive Evaluation Review - This table present the outcomes of the review on incentive evaluation. Evaluation Method: CSRM (Cross-Sectional Regression Model), SBPM (Scenario Based Predictive Model), DCM (Discrete Choice Model), QA (Qualitative assessment)

Ref, Author(s) (Year)	Region	Method	Description of Incentive(s)	Type of Incentive	Main Outcomes
[16] - Gass et al. (2012)	Austria	SBPM	R&D for EV technologies	Regulatory	TCO for EVs can be better than conventional vehicles if policy makers sufficiently support research and development of new environ- mentally friendly vehicle technologies and implement a stringent policy framework
[23] - Hannisdahl et al. (2014)	Norway	QA	Toll exemptions	Financial (Recurring)	Road Tolls, Ferries, Parking are a large part of Norwegian car TCO. In suburban areas with commutes over toll roads, EV sales were and are growing the fastest in Norway
[1] - IEA (2018)	World	QA	Public Procurement Requirements	Convenience	Public Procurement can be used as a stimulus for EV uptake as e.g. zero-emission can be required. This supports OEM scale-up, establishing infrastructure, stimulate emergence of expertise and businesses and increases visibility of EVs
			Financial Incentives	Financial (One-Time)	Measures that reduce the purchase price of an EV have proven to be effective policy instruments to stimulate EV market uptake. This is much in evidence in the Nordic region for the car market (IEA, 2018b) and in China for the bus market.
			ZEV Mandates	Regulatory	The success of ZEV mandates and incentives, first implemented for light-duty vehicles, can be replicated for other modes.
[6] - Langbroek et al. (2016)	Sweden	DCM	Free Parking	Financial (Recurring)	Users indicate a high willingness to pay when this policy is applied, compared to other evaluated factors
			50% discount on parking	Financial (Recurring)	Users indicate a medium willingness to pay when this policy is applied, compared to other evaluated factors
			Access bus lanes (inside city)	Convenience	Users indicate a medium willingness to pay when this policy is applied, compared to other evaluated factors
			Access bus lanes (outside city)	Convenience	Users indicate a medium willingness to pay when this policy is applied, compared to other evaluated factors
			Free Charging	Financial (Recurring)	Users indicate a high willingness to pay when this policy is applied, compare to other evaluated factors
[14] - Larson et al. (2014)	Canada, Manitoba	DCM	Financial Incentives	Financial	Suitable price range for EVs is similar to ICE vehicles. Consumers are unwilling to pay substantial premiums for EVs
			EV Information	Convenience	Consumers with experience with and/or exposure to EVs are more assertive in their purchase decisions.
[8] - Lingzhi et al. (2014)	USA	CSRM	Financial Incentives	Financial	State electric vehicle incentives are playing a significant early role in reducing the effective cost of ownership and driving electric vehicle sales for BEVs, for PHEVs no significant influence was determined. A stepwise regression analysis shows that the most effective incentives are subsidies, HOV / carpool lane access, and emissions testing exemptions initiatives over other incentives such as free parking, public charger availability, home charger subsidies, free electricity and license tax reduction
			Public Charger Avail.	Infrastruct.	
			HOV lane access	Convenience	
			Emissions Testing Ex.	Financial (Recurring)	
			Annual Fee for EVs	Financial (Recurring)	An annual fee (to compensate for loss of fuel tax) has a negative impact on EV uptake
		QA	Public Charger Avail.	Convenience	Public charger availability is an especially cost-effective incentive for BEV owners (author note: as opposed to PHEV)
			Carpool Lane Access	Convenience	Carpool lane access is a cost effective measure targeting for electric vehicle owners
[24] - Ma et al. (2017)	China	CSRM	Financial Subsidies	Financial (One-Time)	Subsidy has an amplification effect and therefore is not equal to the reduction of price (author's note – it is higher)
[25] - Mabit et al. (2011)	Denmark	DCM	Registration Tax Reduction	Financial (One-Time)	The research shows that when given equal choice, users would prefer alternate fuel vehicles over ICE vehicles. The high registration tax in Denmark leaves room for government interventions

Table 3 - continued: EV Incentive Evaluation Review - This table present the outcomes of the review on incentive evaluation. Evaluation Method: CSRM (Cross-Sectional Regression Model), SBPM (Scenario Based Predictive Model), DCM (Discrete Choice Model), QA (Qualitative assessment)

Ref, Author(s) (Year)	Region	Method	Description of Incentive(s)	Type of Incentive	Main Outcomes
[26] - Mersky et al. (2016)	Norway	CSRM	Financial Incentives	Financial	Short-Range vehicles more sensitive to income. Municipal level personal sales sensitive to household income.
			Amount of publicly available chargers	Infrastruct.	Municipal Level - correlation between charging stations and corporate EV sales, causation unclear. Regional Level - correlation between charging stations and EV sales, causation unclear
[27] - Mock et al. (2014)	World	QA	Financial Incentives	Financial	National fiscal policy is a powerful mechanism to reduce the effective TCO and entice vehicle consumers to purchase electric vehicles
			CO2 Emission based Taxes	Financial	Especially effective if non-electric vehicle alternatives generally have relatively high CO2 levels and are subject to high tax rates (e.g. large sized PHEVs in NL)
[28] - Sierzchula et al. (2014)	World	CSRM	Charging Infrastructure	Infrastruct.	No impact on uptake
			Financial Incentives	Financial	No impact on uptake
[19] - Sprei et al. (2011)	World	CSRM	Financial Incentives	Financial (One-Time)	Financial Incentives have a positive effect on vehicle uptake. Regression results show that 1000 Euro of increase of incentive would give 12 % increase in share of EV sales,
[29] - Rietmann et al. (2019)	World	CSRM	Monetary Measures	Financial	Policy measures positively influence the percentage of EVs, specifically monetary measures in interaction with the charging infrastructure when a critical mass of market penetration is reached
			Traffic Regulations	Convenience	Policy measures positively influence the percentage of EVs
			Infrastructure Measures	Infrastruct.	Policy measures positively influence the percentage of EVs, specifically monetary measures in interaction with the charging infrastructure when a critical mass of market penetration is reached
[30] - Wang et al. (2018)	China	DCM	Purchase restriction rescission	Convenience	All policy incentives mentioned can increase the relative attractiveness of EVs to ICEVs and help promote the adoption of EVs. Among these policy incentives, purchase restriction rescission and driving restriction rescission for EVs are the most effective
			Driving restriction rescission	Convenience	
			Access to bus lanes	Convenience	Access to bus lanes deserves the promotion as an effective non-financial incentive

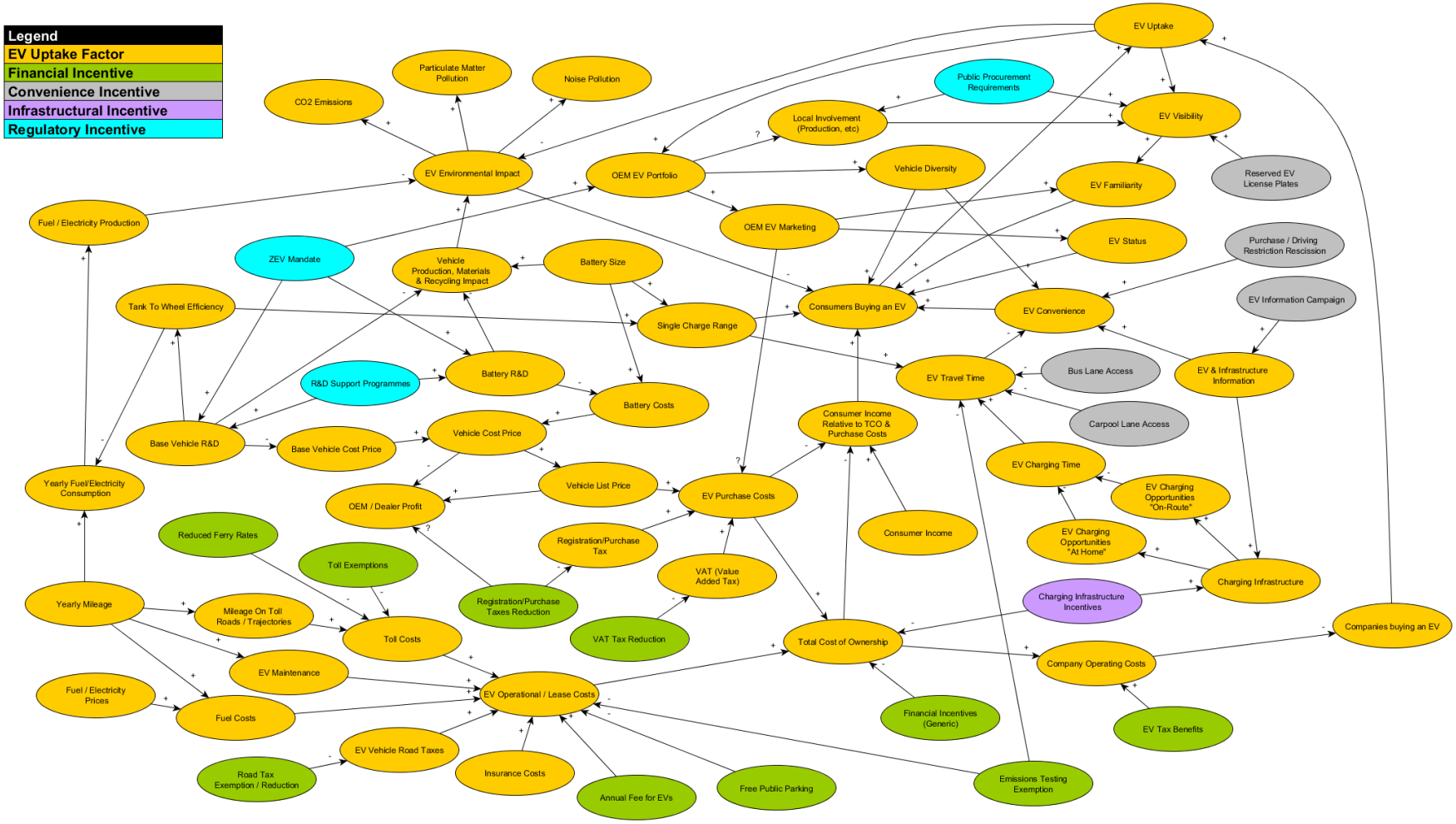

Figure 1: Relational Model for EV-uptake including EV incentives. “+” indicates that if a source increases, the target will increase also, for “-” the target decreases, whereas “?” signifies uncertainty at this point in time

5 Conclusions and Outlook

This research has posed three research questions and has addressed all of them. It could be discerned that there are various strategies to evaluate EV incentives, but there are two main ones that quantify the actual effects of incentives consumer behaviour, being discrete choice models and cross-sectional regression models. The evaluations overall show that incentives do have a positive impact, though it is evidently very hard to quantify exact impacts.

Therefore, a general recommendation to analyse incentives is to always acknowledge (and where possible quantify) the full context of where incentives "hit the EV landscape". To do this, a relational model can be used that describes the pathway that an incentive has "to take" in order to exert an effect on EV uptake. We also conclude that this work has shown, through the use of a relational model, that the impact of EV incentives can be visualized in a structured manner. However, examples and evaluation of the application of this relation model are needed in future work to be able to validate this claim.

In the future, all posed research questions will be addressed in more detail in subsequent research work in the context of this specific project [5]. It will be key to understand how incentives impact different types of users across different demographics characteristics as well as different stages of EV uptake. This is also emphasized in [6] where different levels of effectiveness and efficiency of policy incentives were found depending on the stage of uptake. Next to this, an extension of the research scope will also be considered to address other types of vehicles, namely electric trucks, electric busses or even personal light electric vehicles. As a further outlook, research into understanding and shaping the impact of shared and autonomous mobility trends on the electric mobility system is crucial as these developments will be part of the future EV landscape.

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