How much can we ask respondents to assume in Stated Preference surveys? A field experiment in the context of electric mobility

Romain Crastes dit Sourd, Jean-Christophe Thiebaud Jeremy Shires, Mark Wardman

Context

The Electric Vehicles (EV) market has grown rapidly in the UK over the past few years. The number of EV has shifted from less than 5k vehicles in 2012 to 100k in 2017[1] (out of the 30 million vehicle registered in the UK). EV represented 4.2% of the new registration in 2017, with a majority of those vehicles being plugged-in hybrid vehicle. According to the prevision made by the UK National Grid[2], the number of EV should reach between 5 and 9M vehicles by 2030. In terms of policy, EVs represent a major challenge for the supply of electric power. Indeed, the aforementioned prevision implies that the UK National Grid needs between 3.5GW and 8GW of extra annual capacity depending on whether charging is made in an efficient manner. The lower bound of this estimates represents roughly the power yield of a nuclear reactor. However, the growth of the EV market is also an opportunity for electric networks. Indeed, EV can be used as a power storage unit. Kempton and Tomic [2005] find that the overall light vehicle fleet in the US has 20 times the power capacity of the power grid system but only one-tenth of it is used due to the difficulty of accessing the batteries. In the case of EVs, this power storage capacity is easily accessible.

Vehicle-To-Grid (V2G) systems

A V2G system can simply be described as a system in which battery EVs are linked to the power grid to either return electricity to the grid or to flexibly store and discharge. More precisely, Freeman & al. [2017] indicate that the general purpose of a V2G system is to help reduce the power needed during peak-hours. The EV load their batteries during off-peak hours at a cheap price and then supply the network during peak hours. Moreover, the benefits of V2G can go beyond load management. V2G solutions can also be used to regulate voltage and frequency on the network and support intermittent renewable energy sources (Habib & al. [2015]). However, the implementation of V2G systems faces a certain number of challenges due to the difficulty to fit in this power source within a smart grid and the need to aggregate EV into a pool in order to make the amount of available electricity significant. The dis-benefits of V2G systems can be found in the literature review by Habib & al. [2015]. Most of the discussion is also largely theoretical as V2G systems are still in a very early stage of developments. Despite a growing stream of literature, it remains largely unknown whether consumers would accept to lend their EV to a V2G system in exchange for money. Assessing both the benefits and dis-benefits (loss of flexibility as the vehicle needs to be plugged-in several hours per day, impact on battery life) is crucial for policy making. Moreover, it is also important to understand whether V2G solutions can influence the uptake of EVs.

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[1] Department for Transport Vehicle Licensing Statistics
[2] fes.nationalgrid.com/fes-document/

Measuring the impact of how hypothetical a scenario is on the social demand for a V2G system

The present study proposes to use a Stated Preference survey (SP) approach to understand the joint preferences for different EV and different V2G management systems within the context of a real-world project: the Road to Rail Energy Exchange project (R2REE). The R2REE is very similar to a V2G system as defined above. The technology being developed aims at harnessing the regenerative braking energy of trains and store in temporarily in the battery of electric vehicles before feeding it back to the trains when they accelerate. The scope for implementing such technology in the UK is quite large as the UK has one the largest third rail[3] electrified network. Yet in order to work, a steady pool of commuters with EV would be required to participate in this project. This raises some questions as per how to measures preferences for such a project because the existence of a V2G project might also convince people who only own a conventional vehicle to switch to an EV if they can join a V2G scheme. However, measuring the social demand for a V2G scheme of owners of EV and owners of conventional vehicles is more complex than it looks since owners of EV face a much more hypothetical choice than owners of EV. Hence, the aim of the SP survey is twofold:

i. to assess the willingness to participate in such a scheme, and has been designed in order to have policy implications for V2G in a context of park-and-ride
ii. to compare whether respondents make different choices when they are faced with more hypothetical choices

The SP survey has been designed in such a way as it does not necessarily require the respondents to currently own an EV. About 50% of the respondents would first complete a choice task on which electric vehicle they would like to purchase (3 alternatives including one opt-out) before choosing the V2G contract they prefer (3 alternatives including one opt-out). Such a design allows to better understand to what extends the existence of a V2G scheme can influence the uptake of electric mobility[4].The other 50% would only choose which V2G contract they prefer and <u>would have to assume that they already own an EV</u>. Respondents who *actually* already own an EV will only have to state which V2G scheme they prefer. One choice task example for each integrated choice (EV and V2G contract) is provided below:

Choice of a vehicle
Assuming you have to buy or lease a new car, please tell us which option you would prefer?
Important: Please note all other characteristics of the car (apart from the ones listed in the table below) would remain the same across the three options (speed, size, interior/exterior design, etc)

Choice of vehicle	Electric vehicle 1	Electric vehicle 2	Conventional vehicle
Extra cost at purchase/life of lease (compared to the conventional vehicle)	£10,000	£2,000	No extra cost
Fuel Cost (equivalent to a litre of fuel)	50p per litre	35p per litre	**£1.30 per litre**
Drive Range of the car (miles)	400 Miles	200 Miles	[current]
Charging time at a fast charge point (for instance located at a petrol station)	25 min	40 min	[current]
Preferred alternative	☐	☐	☐

[3] Tramway networks also use DC current but it is distributed using overhead line electrification.

Car Battery Sharing Scheme at the Train Station:
If you agree to share your car's battery, you can enter into a monthly parking contract, which would guarantee you a parking spot at your train station in return for a weekly payment. Additional features include:

- Commitment to park "4" days per week - set in advance
- Commitment to park between "7:30am" and "4:30pm"
- Weekly bonus payment for meeting your commitments

Important: Note that if on any given day you arrived later than "7:30am +20min" or departed before "4:30pm - 20min" you would lose your weekly cash back.

Please select the option you would prefer:

Choice of contracts	Choice A	Choice B	Choice C
For a guaranteed parking spot, you pay per week	£92	£70	I would not wish to subscribe to such a contract
For every week your car is effectively plugged in, the cashback you receive per week is	£10	£5	
Driving range guaranteed at pick-up	100 miles	80 miles	
Estimated impact on battery life per year (this can be either positive or negative)	+ 5%	- 10%	
Preferred alternative	◻	◻	◻

Future work

The questionnaire has been successfully pre-tested and preliminary data has been collected. The final survey will take place in March at various park-and-ride train station across the UK. The collected data will be analysed by the means of state-of-the art choice models including mixed logit models and latent class models, in order to identify the different classes of potential users and reveal the impact of the magnitude of how hypothetical a choice is on respondents' preferences and behaviour

References

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