Energy Policy 116 (2018) 422–432

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Promoting Vehicle to Grid (V2G) in the Nordic region: Expert advice on policy mechanisms for accelerated diffusion

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ARTICLE INFO

Keywords:
Vehicle to Grid
Incentives
Policy support
Nordics
Electricity markets

ABSTRACT

Vehicle to Grid (V2G) holds the promise of cheap, flexible, and fast-responding storage through the use of electric vehicle batteries. Unfortunately, infrastruc.ture, battery degradation and consumer awareness are only some of the challenges to a faster development of this technology. This paper offers a qualitative comparative analysis that draws on a subsample of 227 semi-structured interviews on electric vehicles with both transportation and electricity experts from 201 institutions and 17 cities within the Nordic region to discuss the reasoning and arguments behind V2G incentives and policy mechanisms. A frequency analysis of the most coded V2G responses favours an update of the electricity market regulation – in particular in relation to electricity taxation and aggregator markets – and support for pilot projects. However, the analysis overall implies that V2G, in contrast to EVs, is a technology for the market and by the market. One that will develop on its own over time. More in-depth, our analysis shows the debates around V2G and how its perspective differs per country, pending available frequency capacity and flexible production (hydro power). The paper calls for a further development of flexible electricity markets, support for pilot projects, and attention to information and planning.

1. Introduction

With the increasing uptake of electric vehicles (EVs), which follows from technological development and cost reductions in battery technology and management systems, other business models are opening up that make use of the electric storage and power train of EVs. This includes Vehicle to Grid (V2G), a technology that allows for the retrieval of stored electricity in electric vehicles for the benefit of the electricity networks (Kempton and Tomić, 2005b). Beyond smart charging (load control), V2G offers electricity grid services (e.g. frequency control, spinning reserves, peak shifting), a potential reduction of the investment costs for further grid capacity, the possibility of creating new revenue streams for utilities and vehicle owners (private and fleet), a mitigation of emissions (better optimization of electricity production) and a more efficient integration of renewable energy sources (Kempton and Tomić, 2005a, 2005b; Lund and Kempton, 2008; Niesten and Alkemade, 2016; Noel et al., 2017; Sovacool et al., 2017a).

Irrespective these benefits, the technology remains in its infancy although the number of pilot projects is growing and some of these are commercially active, such as in Frederiksberg, Denmark (NUVVE, 2017). These and other pilot projects are carried out around the world, with more and more research institutes, OEMs and grid companies showing interest and a willingness to invest (Sovacool et al., 2017a). Consequently, the literature around these projects is rapidly generating insights into the barriers to a further uptake, including communication complexity, costs, battery degradation, and competition from other flexible storage technologies (Bailey and Axsen, 2015; Parsons et al., 2014; Sovacool et al., 2017a; Turton and Moura, 2008). Consumer acceptance is another important barrier, as V2G is seen to impede on the 'freedom of the car' (Parsons et al., 2014) and the privacy of consumers (Bailey and Axsen, 2015).

In response to this growing body of literature, this paper draws on 227 expert interviews with 257 respondents involved in electric mobility (from the car industry, electricity sector, academia and government) from all five Nordic countries (Iceland, Sweden, Denmark, Finland and Norway) to see what kind of policy mechanisms could help promote V2G. As such this paper offers a more qualitatively focused examination of policy mechanisms in contrast to the more technical in-depth analysis of Knezović et al. (2017) or Uddin et al. (2018). Our aim is to use these expert interviews to identify and prioritize the list of policies that would best address the barriers facing V2G.

Unfortunately, V2G remains a relative unknown technology even among experts working with or around electric mobility. A clear indication of this is that although 85% of the interviews were willing to

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https://doi.org/10.1016/j.enpol.2018.02.024
Received 13 October 2017; Received in revised form 14 February 2018; Accepted 14 February 2018

Table 1
Overview of semi-structured research interview data.
Source: Authors. Focus represents the primary focus area of the organization or person in question, sector represents the sector the company was working in (semi-public referring to commercial companies owned by public authorities, like DSOs).

Classifications	Interviews (n = 227)	Respondents (n = 257)	% of respondents	% of interviews discussing V2G	% interviews offering specific V2G recommendations
Country = Iceland (Sept-Oct 2016)	29	36	14.0%	7%	0%
Country = Sweden (Nov-Dec 2016)	42	44	17.1%	15%	2%
Country = Denmark (Jan-Mar 2017)	45	53	20.6%	18%	5%
Country = Finland (Mar 2017)	50	57	22.2%	18%	7%
Country = Norway (Apr-May 2017)	61	67	26.1%	25%	8%
Gender = Male	160	207	80,5%	61%	19%
Gender = Female	40	50	19.5%	14%	4%
Gender = Group	27			8%	1%
Focus = Transport or Logistics	73	81	31.5%	25%	7%
Focus = Energy or Electricity System	63	75	29.2%	26%	11%
Focus = Funding or Investment	10	12	4.7%	3%	0%
Focus = Environment or Climate Change	12	16	6.2%	4%	1%
Focus = Fuel Consumption and Technology	22	23	8.9%	8%	0%
Focus = Other	13	14	5.4%	4%	1%
Focus = EVs and Charging Technology	34	36	14.0%	14%	3%
Sector = Commercial	68	70	27.2%	26%	8%
Sector = Public	37	46	17.9%	12%	3%
Sector = Semi-Public	40	51	19.8%	13%	5%
Sector = Research	37	39	15.2%	15%	4%
Sector = Non-Profit and Media	12	13	5.1%	4%	1%
Sector = Lobby	23	25	9.7%	8%	1%
Sector = Consultancy	10	10	3.9%	4%	1%

discuss the benefits and downsides of V2G, only 23% of the interviews offered concrete policy related suggestions. The results are of interest however and include a need for public support to help restructure the electricity markets, further incentivize innovation and business development, create the facilitating conditions that V2G needs, fill the knowledge and information gap for consumers, EV experts and small distribution system operators (DSOs) lacking the expertise and manpower to study this thoroughly, and support V2G capable charging infrastructure. Interestingly, these suggestions are mainly focussed on the electricity sector and ignore the automobility sector or consumers. Simultaneously, 5% of the experts believe that public authorities cannot do much, or actually already have done plenty, and that it is just a matter of time for V2G to find its place in the electricity markets. In the following sections, this paper discusses these policy mechanisms in more detail.

2. Method

As our primary method, the authors conducted 227 semi-structured interviews with 257 participants from over 200 institutions across each of the five Nordic countries from September 2016 to May 2017. Table 1 provides an overview of this method. The goal of the interviews was to get a state of the art overview of the challenges and expectations that people involved in electric mobility have about electric mobility. The choice for semi-structured interviews follows the complexity and fast changing nature of the topic of electric mobility (including V2G) as they allow for a timely and in-depth discussion of such a complex issue where a lot of elements are connected, political choices are needed and individual perceptions and values play an important role (Harrell and Bradley, 2009; Yin, 2013).

Unfortunately, semi-structured interviews are open to three biases. First, interviews are open to self-selection biases when only those interested accept the invitation. Second, interviews are open to interviewer biases, as the follow up questions are the prerogative of the interviewers. A third bias relates to the level of expertise of the respondents. In certain instances, experts only mentioned more common points after a follow up question, stating that those were common knowledge, or vice versa, primarily focussed on what they felt knowledgeable about while ignoring other aspects.

To explicitly minimize these limitations with an interview approach, we utilized a research design that was large, reliable, verifiable, and triangulated. To minimize self-selection bias, we relied on a substantially large number of interviews—more than 225—when most studies in the energy field and the social sciences rely on fewer than 15–50 (Baker et al., 2012; Galvin, 2015) especially when interviews are with elite respondents such as experts. To minimize interviewer bias, we relied especially in the beginning on varying two person teams of interviewers. We also recorded and fully transcribed all interviews, making them both more reliable and verifiable. To minimize expertise bias, we triangulated the interviews both with each other (internal validity) as well as the relevant peer-reviewed literature (external validity). We would also add that interviews come with their own set of strengths, which can counter potential weaknesses: interviews can and should explore the full range of views or arguments available on a certain topic (Glaser and Strauss, 2006), thereby offering more complex responses when compared to more static methods such as surveys or diaries.

In terms of our specific interview sample, those interviewed in Denmark, Finland, Iceland, Norway and Sweden were selected to represent the diverse array of stakeholders involved with electric mobility, from both a transport and an electricity side, and include:

- National government bodies, including the Ministry of Industries & Innovation (Iceland), Ministry of Environment and Energy (Sweden), Ministry of Finance (Finland), and Ministry of Taxation (Denmark):
- Local government ministries, agencies, and departments including the Akureyri Municipality (Iceland), City of Stockholm (Sweden), Aarhus Kommune (Denmark), City of Tampere (Finland), City of Oslo (Norway), and Trondheim Kommune (Norway);
- Regulatory authorities and bodies including the National Energy Authority (Iceland), Danish Transport Authority, Helsinki Regional Transport Authority (Finland) and Trafi (Finland);
- Universities and research institutes including the University of Iceland, Swedish Environmental Institute, DTU (Denmark), Aalborg University (Denmark), VTT Technical Research Centre (Finland), NTNU (Norway), and the Arctic University of Norway;
- Electricity industry players such as ON Energy (Iceland), E.ON