

Advantages of Electric Vehicle adoption and Vehicle-to-Grid charging in the fleet market: Lessons from the V2GO project



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This briefing summarizes findings from the Vehicle-to-Grid Oxford project, funded by Innovate UK. The research was conducted by the Transport Studies Unit, University of Oxford. The results set out the role and advantages of using the Vehicle-to-Grid (V2G) system in fleet management, the current barriers to its uptake, implementation strategies and policy recommendations. This briefing has been written for policy-makers and fleet market professionals.

INTRODUCTION

What is V2G and why is it important?

A swift transition from fossil-fuel-powered to electric vehicles is essential to meeting targets to reduce greenhouse gas emissions and air pollution from transport. There is some concern that the electricity grid can be overwhelmed when the number of electric vehicles increases rapidly, especially when wind and solar energy becomes the main source for electricity production. Vehicle-to-grid (V2G) technology can help to stabilize the grid.

V2G technology enables electricity to flow not only from the electricity grid to the vehicle during charging, but also from the vehicle back to the grid. These flows can be managed to reduce peaks in electricity demand at grid level and lower electricity costs for vehicle users. The electricity stored in vehicle batteries can be released to the grid when demand is high. Therefore, V2GO can not only generate income for the vehicle users but also provide them with back-up electricity. Fleets offer a prime opportunity for installing V2G technology and can be frontrunners in the decarbonization of road transport.

BACKGROUND

The vehicle fleet market

Vehicle fleets are responsible for a large share of the greenhouse gas emissions from road transport in the UK. It is, however, difficult to say how important exactly fleets are. This is because there is neither a commonly accepted definition of what a fleet is, nor a clear overview of the number and size of fleets in the UK. According to the Department for Transport, 5.5 million vehicles were registered to companies or commercial operators in 2018, of which 2.8 million were cars and almost 2 million Light Goods Vehicles (vans). In that year 57.3% of new cars were first registered by companies although many of these were moved to the private market within a year. Additionally, sector organization BVRLA estimated that in 2016, around 14 million private vehicles were part of the “grey fleet” of private vehicles used for and subsidized by business. In the research we have concentrated on cars and

vans and define fleet vehicles as all vehicles whose use is paid for and managed by businesses and other organizations.

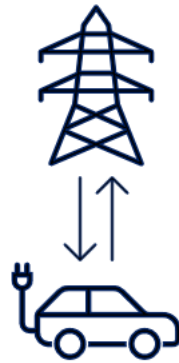
Fleet management

Fleet management refers to the operations involved in the handling of a vehicle fleet and therefore is a critical intervention point for the decarbonization of the UK’s transport sector. Fleet management entails a range of activities over the “fleet cycle”, the period during which vehicles are used by businesses and organizations. There is the initial selection process of new vehicles, followed by purchasing or leasing. Subsequent activities involve maintenance and operations planning, driver control and support, fuel

management, use of telematics to track vehicles, and finally remarketing of the vehicle. Nowadays, many of these activities are outsourced to fleet management or lease companies, particularly in smaller firms. In organizations that manage their fleet in-house, the activity management is often only a part-time task allocated to people whose main job is, for example, in HR or finance.

Three reasons for introducing V2G in fleets:

- 1) Collective installation of charging infrastructure
- 2) Predictable and limited vehicle use patterns
- 3) Controlled environment for testing and managing V2G



Key Benefits of Vehicle-to-Grid

Vehicle-to-Grid refers to a system in which Electric Vehicles can return electricity to the grid. It can have multiple benefits:

- V2G can stabilize electricity grids by providing back-up capacity in case of unexpected outages or assisting with the constant balancing of supply and demand in the grid (frequency regulation)
- V2G can facilitate the introduction of solar and wind energy. These sources do not always provide energy. When they do excess energy can be stored in Electric Vehicle batteries. When this is needed, electricity can then be returned back to the grid
- V2G can provide additional value for fleet managers, for example in the form of cost savings or a contribution to environmental goals

Trends in the UK fleet market and their expected effects on V2G

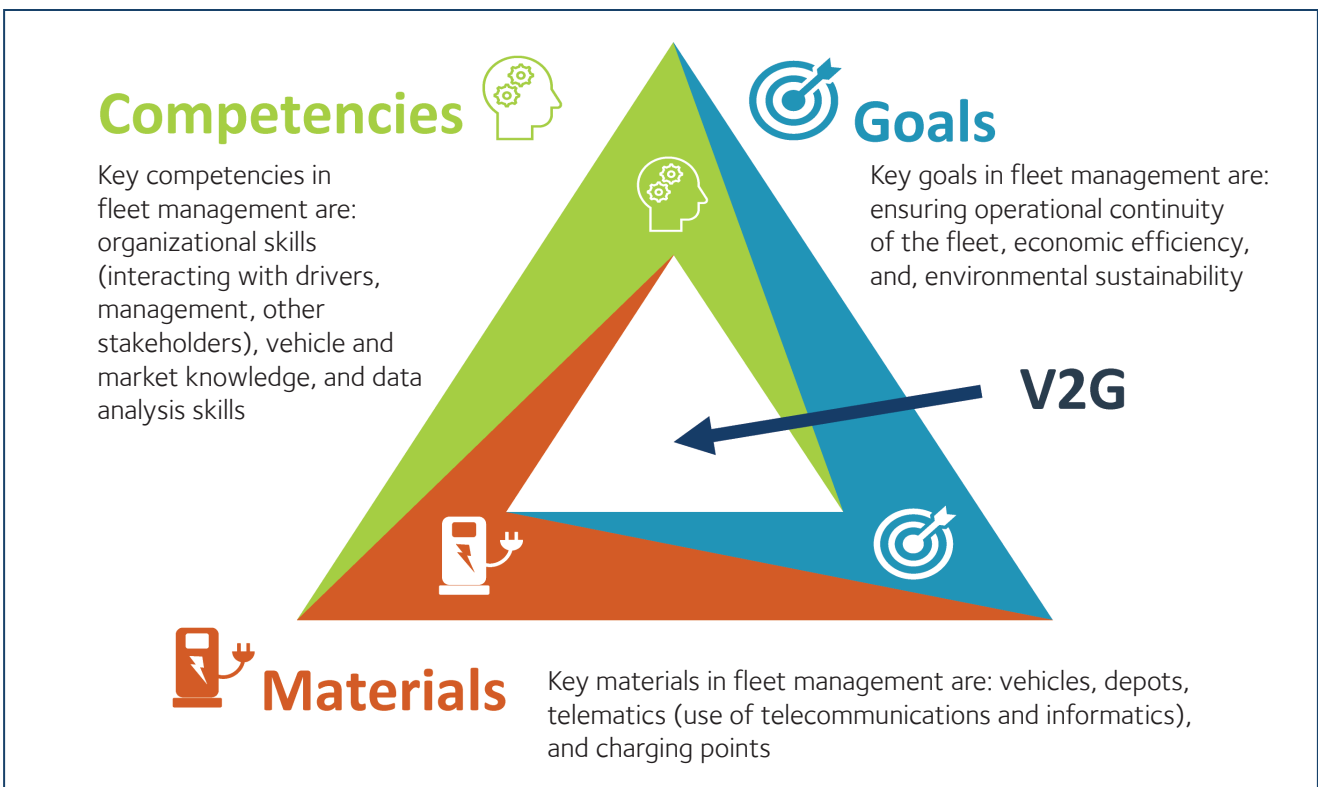
The fleet market is currently undergoing profound changes. Based on interviews with fleet experts we investigated these socio-technical trends and their likely effects on the potential of V2G in fleets. The identified trends provide a starting point for developing policies and implementation strategies for V2G.

Changes in the UK fleet market and their expected effects on V2G		
	Key trends	Implications for V2G
User preferences	Growing interest and demand for electric vehicles	More Electric vehicles potentially available for V2G, yet awareness of V2G among fleet managers still low
Use patterns	Increasing vehicle usage times in specific sectors and organizations	Reduction of V2G potential because of reduced and increasingly uncertain plug-in times
User characteristics	Increase in number of Small and Medium-sized Enterprises (SMEs), rise of self-employment	<ul style="list-style-type: none"> ▪ Increase in importance of SME-specific barriers to innovation adoption ▪ Lower potential for large-scale V2G installations in depots
Technology	Improvements in electric vehicle battery technology and manufacturing	More electric vehicles potentially available for V2G, but bi-directional charging capabilities still highly limited
	Increasing availability of telematics	Easier implementation and management of V2G in vehicles
Infrastructure	Rapid growth in electric vehicle charging infrastructure	<ul style="list-style-type: none"> ▪ Charging infrastructure bottlenecks provide impetus for V2G ▪ Risk of lock-in without V2G, because of installation of non-compliant electric vehicle infrastructure
Policy	Continuous support for electric vehicle implementation, with increasing importance of Low Emission Zones	More electric vehicles available potentially for V2G, but spatial differences in uptake more likely
	Uncertainty regarding influence of electricity market policies on V2G	Fleet managers and other actors might lack certainty and confidence to invest in V2G-capable electric vehicles

IMPLEMENTATION STRATEGIES

Implementation of V2G in fleet management

Fleet management can be understood as a “social practice”, a set of routinized behaviours that require specific competencies, fulfil certain goals and require a range of materials as input and equipment. Changes in all these three elements are required if the uptake of V2G in fleets is to be increased significantly.



The model of fleet management focused on competencies, materials and goals can be used to identify important **barriers** to V2G uptake in fleets. The model also helps identify two types of intervention strategies to overcome those barriers as set out *below*. ‘**Fit strategies**’ help V2G to work better with existing competencies, goals and materials. ‘**Transform strategies**’ are focused on fundamentally changing competencies, goals and materials of fleet management in order to facilitate V2G.

Competencies

Barriers: Limited data analysis skills mean companies cannot assess the benefits of implementing electric vehicles and V2G. Lack of knowledge about V2G and its multiple applications makes organizational implementation of V2G difficult, because of the variety of stakeholders inside and outside the firm that are involved.

Fit strategies: Trials with V2G vehicles can help to develop knowledge about benefits and implementation, while on-the-job training of drivers can cultivate skills among employees. Fleet managers can identify “organizational champions”, for example employees who are environmentally concerned or technologically curious, to foster V2G implementation within the organization.

Transform strategies: Professionalization of fleet management, with a focus on developing specialist fleet knowledge and clear procedures, can encourage informed decisions about electric vehicles and V2G implementation. Improvement of data analysis capability and skills will make it easier to assess and evidence the benefits of V2G.

Materials

Barriers: Current telematics systems are not tailored to V2G and sometimes perceived as hard to use. Lack of grid capacity and limited vehicle parking space complicate V2G introduction.

Fit strategies: User-friendly telematics systems that assess V2G viability and monitor charging and battery state of health can be implemented. Grid connections can be upgraded.

Transform strategies: Grid capacity and availability of space to park and charge vehicles become integrated into the criteria for the selection of new depot locations.

Goals

Barriers: Concerns that temporary breakdown of V2G chargers or long-term battery degradation might endanger the operational continuity of fleets. The exact effects of V2G on economic efficiency and environmental sustainability are as yet unknown.

Fit strategies: Clear warranty agreements for batteries should be put in place. Fleet managers are offered quick replacement vehicles in case of charger breakdown. The use of telematics can provide estimates of the potential economic and environmental benefits of V2G.

Transform strategies: V2G implementation can be encouraged by periodic re-evaluation of fleet management goals and the putting in place of a sustainability model in order to balance economic, environmental and social goals. This is illustrated by an estates director who is involved in fleet management and participated in our study:

“So clearly there’s an economic argument looking at what the vehicle is going to cost me, what’s the depreciation on it, what’s the energy that I can save and what’s the energy that I can put back into the grid. Then you’ve got your social which is your ability to lead the change agenda, your responsibility to the operator of the vehicle and all the safety and then you’re looking at your environmental which is how do you reduce your carbon footprint.”

The importance of fleet size in promoting V2G to SMEs

Although there are a few large fleets in the UK, such as Royal Mail, a distinctive characteristic of the fleet market is the “long tail” of SMEs with only a handful of vehicles. Because SMEs often do not have a dedicated, fulltime fleet manager, there often is limited knowledge about the fleet and little opportunity to build up that knowledge. This is an important barrier to V2G uptake, because fleet managers often perceive V2G as a complex technology. Moreover, small firms, particularly

in sectors with low profit margins such as delivery and construction, tend to have limited resources to make investments in electric and V2G-capable vehicles and infrastructure. Finally, V2G is expected to work well in large-scale installations with multiple chargers. Such installations can offer cost advantages, and a certain minimum level of predictable electricity provision to the grid.

Three recommendations for SMEs to overcome barriers

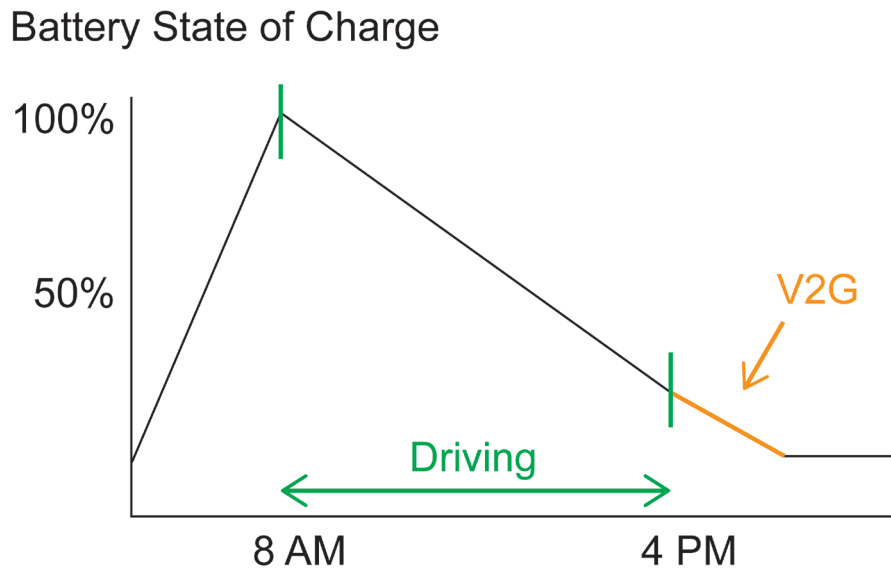
1) Intermediary organizations, such as sector associations, consultancy firms and government units should provide SMEs with knowledge and resources to professionalize fleet management and increase awareness about V2G

2) Leasing firms, which are an increasingly important party in fleet management, could be much more

proactive in promoting V2G among their clients

3) The regulation of certain sectors, such as logistics, should be reconsidered. An increasing number of small firms and self-employed operators compete in a low-margin “gig-economy” model. Different forms of sector organization could make introduction of V2G easier, and contribute to wider sector sustainability.

The importance of timing in the charging cycle to optimise energy saving and efficiency



V2G can be used to extract remaining electricity out of a fleet vehicle's battery after it has been returned to the depot in the early evening when demand for electricity is peaking. In the scenario shown in the graph, the vehicle comes back to the depot at 4pm with 30% of the battery left. Electricity is then provided to the grid until the vehicle has 10% State of Charge left. The vehicle is recharged using cheap electricity during the night and ready to leave again at 8 am the next morning. During interviews this scenario was discussed with fleet managers from a variety of organizations, which yielded three main insights about the temporal dimensions of V2G use in vehicle fleets.

Three lessons about V2G and time

- 1) *Variation matters*: Although fleet usage patterns have a certain regularity, there are differences in the times at which specific vehicles in an organization's fleet are used. This means that an organization-wide approach must be adopted in assessments of the V2G suitability and use.
- 2) *Safeguard control and trust*: Fleet managers felt strongly about their degree of control of the V2G charging process. This means that programmable charging management systems must be reliable and that good relationships between fleet managers and the suppliers of such systems are essential.
- 3) *Rethink rhythms*: Fleet managers were very reluctant to adapt their fleet operating schedules to make them fit better with V2G. The rhythms of fleet operations are tightly coupled with other rhythms in society, such as our shopping habits. In one of the interviews a fleet manager of a furniture firm who had changed delivery schedules explained how this involved extensive interactions with clients. He asked them, for example, whether next-day delivery was really needed. Such an approach might work for some organizations but not for all. To maximize the environmental benefits of V2G use in fleets, we need to think about which societal rhythms can be adapted and how this can be done most effectively.

MARKET ADVANTAGES

The value of V2G for different market segments

The economic value of V2G is currently uncertain. Recent estimates range from around GBP 100 to GBP 500 per vehicle per year. Important factors that influence the economic benefits of V2G in fleets include the times at which vehicles can be plugged in, the development of competing battery storage technologies and, notably, energy policies. It is, however, important to emphasize that V2G creates a wider range of benefits beyond economic value. The figure below demonstrates these benefits for different types of organizations and offers a matching market narrative. The benefits and narratives have been derived from in-depth interviews with 17 fleet managers in different kinds of organization.

The value of V2G for different market segments			
	Large logistics firm	Sustainability-oriented organization	Cost-focused SME
Value	<ul style="list-style-type: none"> Measurable reduction in total costs of ownership for the fleet Concrete CO₂ reduction to achieve firm targets 	<ul style="list-style-type: none"> Increase use of locally generated energy CO₂ reduction Environmental leadership 	<ul style="list-style-type: none"> Reduce costs of moving towards low-emission vehicles
Market narrative	V2G helps us “reduce carbon emissions and costs by clear numbers as compared to smart charging”	V2G helps us “look after Oxfordshire”	V2G helps us “make the business case for buying electric vehicles work”

POLICY RECOMMENDATIONS

Policies for V2G: alignment and predictability needed

V2G is an innovation that brings together the energy and mobility systems. This generates complexities in the policy domain. Car taxes in the UK are currently set until 2025, offering certainty for fleet managers, who often make investment decisions about vehicles for a period of 4-5 years, and making the switch to electric vehicles easier. Energy policies that influence the attractiveness of new technologies like V2G tend to change rapidly, as is the case with Ofgem’s Targeted Charging Review for instance.

More stability in the policy domain would reduce uncertainty around V2G’s benefits as perceived by fleet managers. Policies around business support and skills development could also be coordinated to take account of the development of new technologies like V2G. Furthermore, greater coordination of policies by the Department for Business, Energy and Industrial Strategy (BEIS) with those of other departments and regulators such as Ofgem could also encourage V2G uptake by fleet managers.

Further recommendations for government policy

Create a V2G taskforce, possibly within the Office for Low Emission Vehicles (OLEV), with a double role to:

- 1) Review and coordinate policies influencing V2G across departments and regulators
- 2) Periodically publish a multi-year overview of the policies, and likely changes in these, that will change the economic benefits of V2G to organizations. This will aid fleet managers in making decisions about V2G investments according to their usual 4-5 year time horizon

About the Project

The current report was produced as part of the Vehicle-to-Grid Oxford project (V2GO), an Innovate UK funded Real World Demonstrator project (Competition code 1705_CRD_TRANS_V2G_DEMO) involving Arrival, EDF Energy R&D UK, EO Charging, Oxfordshire County Council, The Virtual Forge, Upside Energy and The University of Oxford.

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About the Transport Studies Unit

The Transport Studies Unit (TSU) has been the centre of transport research excellence within the University of Oxford since 1973. The TSU hopes to inspire and inform change towards a more sustainable, just and accessible transport system by advancing understandings of the systems, processes and practices that shape the way people and goods move. Based within the world-leading School of Geography and the Environment at the University of Oxford, the TSU approaches global transport challenges from social science and holistic perspectives. Its work is organized in four broad themes: energy, climate and environment; politics, power and governance; everyday life and justice; and health and wellbeing.

