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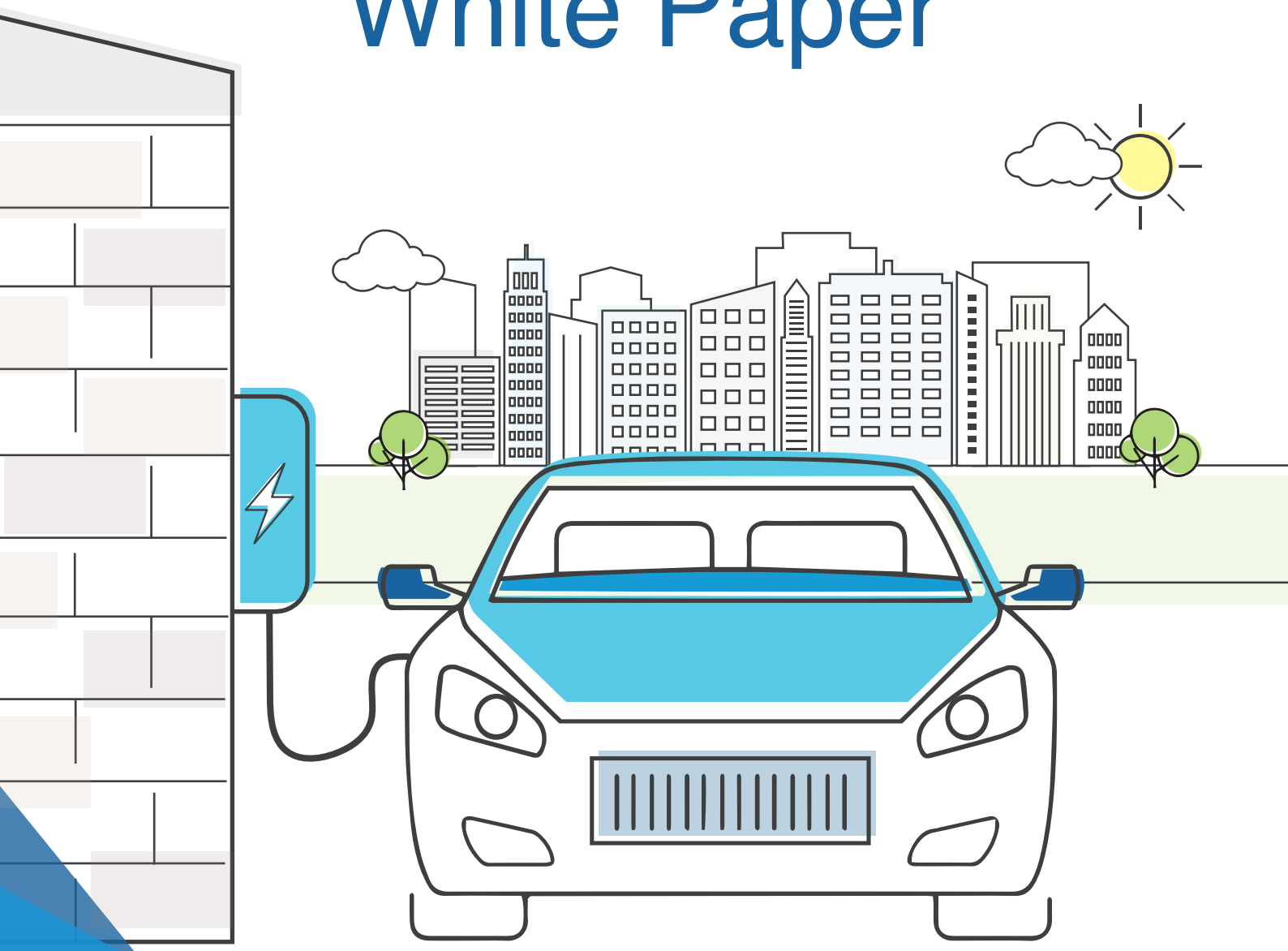
Commercial Viability of V2G:

Project Sciurus White Paper



January 2021

Is V2G really ready?

project sciurus

Vehicle-to-Grid technology, or V2G has been a buzz word in the industry for a number of years now. It is often perceived as a future technology that will be realised in a distant, green, utopian future. However, this view is now being challenged as we begin to see V2G being deployed at scale and its benefits demonstrated in the here and now.

Back in 2015 the first V2G unit was deployed in the UK. It was roughly the size of two filing cabinets and required an entirely bespoke setup in order to function. In the subsequent five years, the technology has come a long way, with now four models available in the UK through different suppliers and new suppliers entering the market regularly.

Today, one of the largest Vehicle-to-grid demonstrators in the world, Project Sciurus has combined experts in energy, transport, and infrastructure to develop a real-world domestic solution for V2G.

When the project started back in 2018, there were only a handful of V2G chargers in the UK and only one domestically installed unit. Now in Project Sciurus alone there are 325 V2G units in real homes across the UK.

It has not all been plain sailing to get to this point, but the project has paved the way to deploy fleets of V2G chargers across the UK...

- We now have a UK manufacturer (Indra) making wall mounted domestic V2G chargepoints which are CHADEMO certified, G98 and G99 type tested and CE certified.

Figure 1: The Indra V2G Charger

- Kaluza's Intelligent Energy Platform is able to monitor all the chargers and decide the best charging schedules to follow based on the customer needs, energy wholesale and balancing markets.

Is V2G really ready?

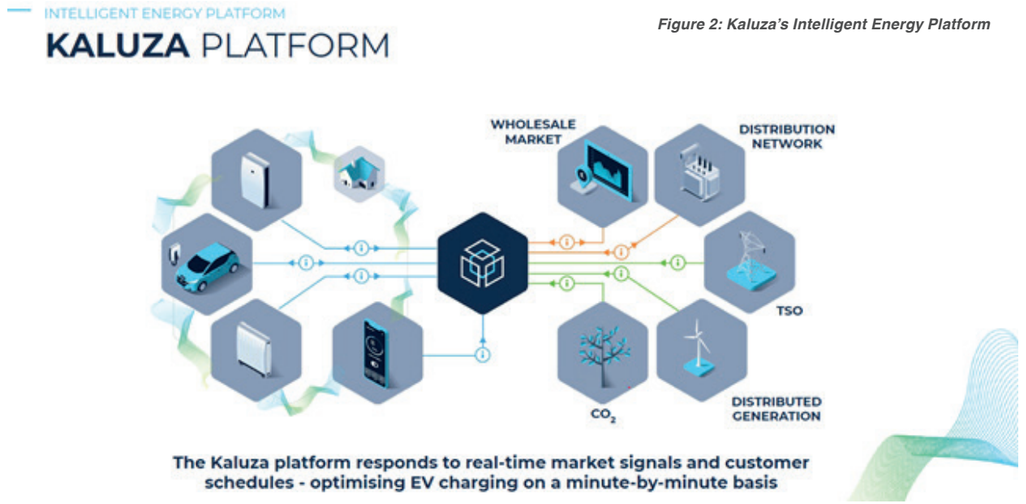


Figure 2: Kaluza's Intelligent Energy Platform

- A Customer App allows OVO Energy customers to monitor car import and export, programme 'ready by' times, set a preferred charging range for the battery and boost charging in the event they need to use the car on a short notice and want the charger to operate at full capacity regardless of the market conditions and platform commands.

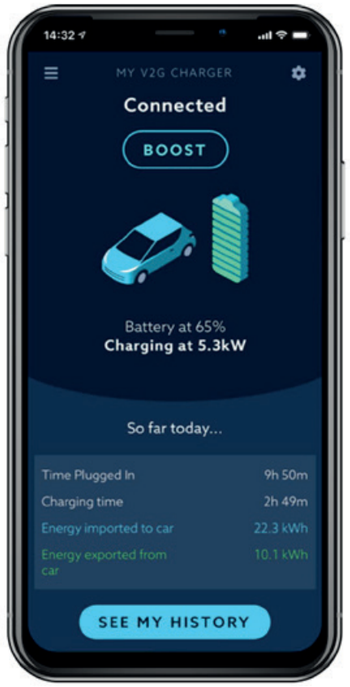


Figure 3: The OVO Customer App

- The cost of the hardware has been brought down significantly. At the beginning of the project, buying a V2G unit would cost in the region of £15k, plus installation. Through the innovations and efforts of Project Sciurus and other V2G projects the cost of a V2G unit has reduced significantly, with typical single-phase V2G units costing £4-6k, and the Indra unit retailing to end users at approximately £5k including installation.

Along the way there have of course been challenges to overcome:

> Obtaining CHAdeMO certification for the unit.

> Gaining approval for the V2G operation to be covered under the battery warranty.

> Getting the customer proposition right.

> Navigating a complex customer on-boarding journey with DNO engagement.

> Dealing with more complex installs with existing chargers or on-site generation.

And many others besides. However, five years after the first V2G unit arrived in the UK, there is now a fleet of 325 home grown V2G chargepoints in homes across the UK, optimising energy to look after the EV battery, the grid, and the customers' needs.

Is V2G really ready?

What is Flexibility?

In the electricity system it is important that at any given time total generation and total demand always match. Given the difficulty in accurately forecasting either of these, flexibility is used to make sure they do match. Flexibility is the ability to change a planned electricity consumption (in the case of demand) or production (in the case of generation) pattern at short notice. Additionally, flexibility can be used to move consumption to periods where cheaper or renewable generation is available.

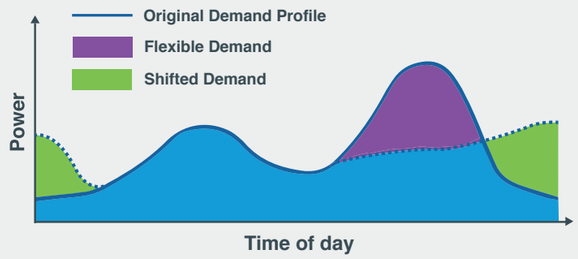


Figure 4: How Flexibility Works

Why is V2G important?

The switch to EVs now seems all but inevitable, with the UK ban on the sale of ICE cars coming in from 2030.

The impacts on the energy system of such a switch are huge, with an additional annual electricity demand of over 80TWh per year by 2050 predicted [NG FES 2020]. The addition of such a load will require smart coordination and flexibility if we are to avoid the largest costs that would come from increasing the electricity network and generation capacity to cope. With the rise of intermittent renewable generation, the requirements for flexibility are now moving from generation assets to demand.

Smart charging of EVs, whilst a necessary source of flexibility, can only do so much. In National Grid's Future Energy Scenarios published in summer 2020, they demonstrate the relative impact that both Smart and V2G charging may have on a future energy system. In their Consumer Transformation scenario, they simulated the effect of 73% of EV charging becoming Smart by 2050. The impact on the EV charging electricity demand at the Winter peak is shown in the chart by the dotted and dashed lines. However, if just 26% upgraded to V2G, then the net EV charging demand at the peak could become negative.

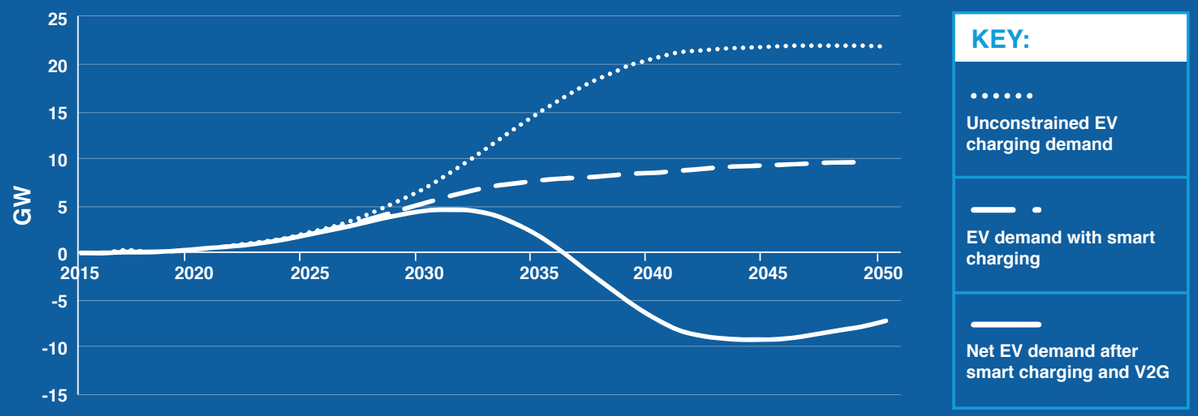


Figure 5: Electric Vehicle charging behaviour at ACS winter peak system demand (Consumer Transformation Scenario) – Source National Grid FES 2020.

Why is V2G important?

Revenue-Generating Energy Trading	Using the EV as an energy storage asset for financial reward.
Resilience	Using V2G to provide back-up power or uninterruptible power supply
Personal Net Zero / Self Sufficiency	This environmentally focused value proposition helps the user to optimise self-consumption of energy generated by on-site renewable energy technologies such as small-scale wind and solar PV.
Benefit to Society	This is about engaging with V2G for altruistic reasons; doing your bit for the greater good of helping to solve wider society's environmental challenges.
Enhanced Battery Management	Preserving the health of an EV's lithium-ion battery is vital. Multiple benefits can be realised by maintaining an acceptable capacity and power over its lifetime.

In our recent report "A Fresh Look at V2G Value Propositions ", we covered five key value propositions for V2G. These demonstrate that the benefits of V2G run much broader than a simple immediate financial gain.

The battery is the most valuable component of any EV, and some owners are already showing that they value ways of looking after this asset. V2G charging algorithms, that return the state of charge to a mid-position avoiding the EV sitting at extremes for long periods of time, could prove attractive.

Customers on the trial agree that V2G is important. Over 70% of those surveyed say that it is important that their next EV is V2G capable.

> **There's nothing else to do other than plug the car in every time you get in and unplug it when you go out. Everything else is done for you.**

> **When I'm not using my car, it's in the garage and plugged into the grid. This means electricity can flow both ways – topping up when there's lots of electricity and exporting to the grid when there's not.**

Does it make money?

One of the key factors concerning how much value V2G chargers can create, is the percentage of the time that an EV is connected to them.

Without an EV of course, the charger can do nothing. Existing EV drivers with home chargers typically have their EVs plugged into them less than 30% of the time. With drivers only plugging their vehicles every two to three days . What we've found in Project Sciurus is that an incentive to plug in more often does work, with V2G users keeping their vehicles pugged in at an average of around 57% of the time. In fact 75% of trial customers surveyed said that they plug the EV in after every trip.

The key revenue streams for V2G in a domestic context are:

> Optimisation against a Time of Use tariff

> Offering flexibility to central markets via an aggregator

> Maximising self-consumption of on-site PV generation.

Modelling performed by Cenex using data from the Sciurus trial show that from the first two revenue streams above, V2G could make around £410 per year when compared with unmanaged charging. By comparison, Smart charging using the same data set, could only make £172 per year.

For further information on revenue available from V2G please see the Cenex report "**Understanding the True Value of V2G**".

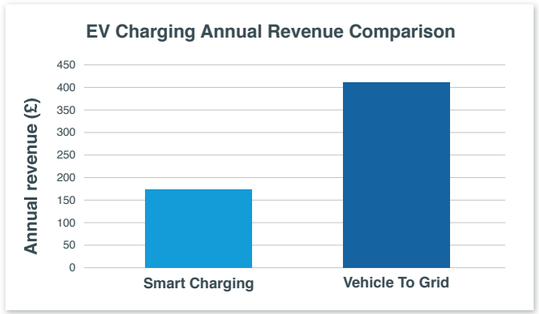


Figure 7: Annual Revenue for Smart and V2G Charging

During the trial, the participants were provided with a simple proposition by OVO Energy. They would be paid 30p per kWh of energy exported from the property (or 26p per kWh if they have existing microgeneration). On average customers have been paid £80 per month in V2G credits, which has resulted in approximately £30 a month net energy bill savings, or £360 per year. This simple proposition resulted in a good match with the modeled potential revenue.

The credit for the energy you export is paid a month in arrears. Last month, the credit exceeded the amount I spent in gas and electric for the house and car – this meant I received a credit of £28. The credits and interest will leave my payments over a year in advance, so my gas, electricity and fuel bills for the car will all be free.

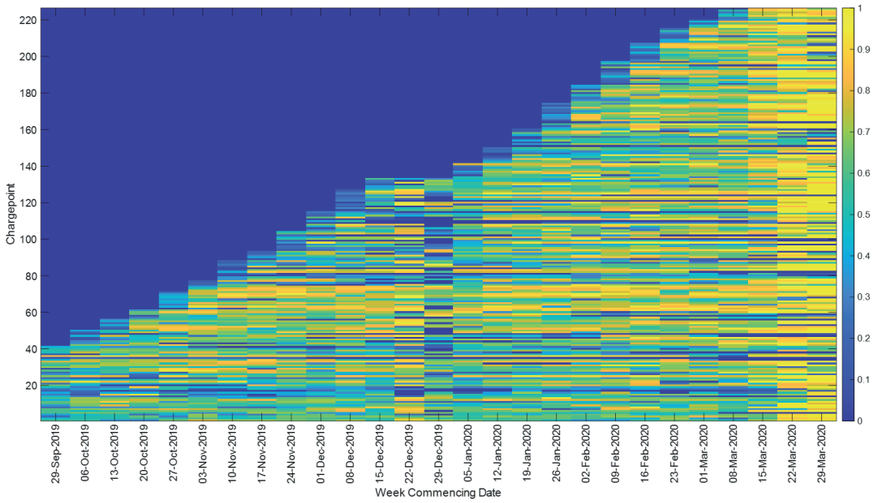


Figure 6: Heatmap Showing Plug-In Rates During Sciurus Trial

What about the future?

The energy and transport industries are no-longer slow-moving sectors, with disruptive innovations such as V2G breaking the existing models and systems on an increasingly regular basis.

Equally innovation even within V2G technology and the wider energy landscape is rapidly changing and developing. For V2G there are a number of important factors that are expected to have a significant impact on how the technology and its market develop.

Firstly, from April 2021 export DUOS charges for domestic customers (which are currently flat) will be charged at different rates at peak and off-peak hours. This price differential will be a benefit to technologies that can chose when to export power, such as V2G. However, the Targeted Charging Review (TCR), now due to be implemented in April 2022, will reduce the differential between peak and off-peak import electricity prices for domestic customers. This will reduce revenue captured by V2G, counteracting the increases in revenue the year before from the DUOS export changes.

New flexibility products are also emerging, such as the Dynamic Containment product from National Grid ESO, and DNO flexibility products are also gaining traction. However, the exact values from these markets is uncertain and for DNO flexibility they are heavily location dependent.

Back in 2019, as part of Vehicle-to-Grid Britain , (the Innovate UK project funded by BEIS and OZEV) Element Energy made price reduction predictions for the nascent V2G hardware market. As of the time of writing, we estimate that the premium for a V2G charge (above a Smart charger) is around £4,000. This already puts us in the price range predicted for 2022. If revenue streams for V2G remain constant, then the prospects of V2G will be improving over the coming few years.

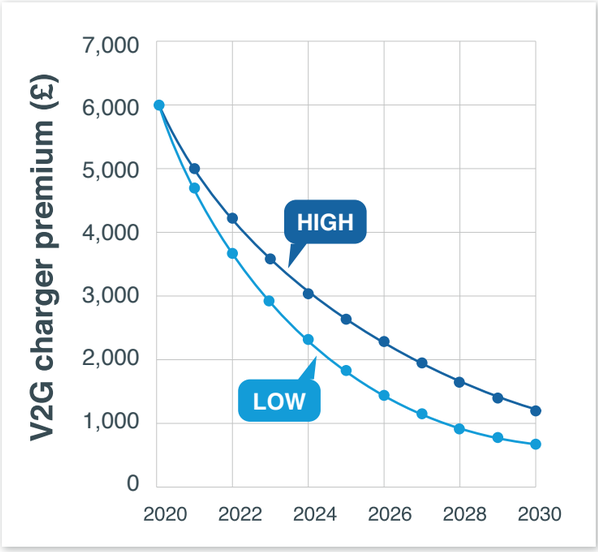


Figure 8: Projected V2G charger premium
Source: Vehicle to Grid Britain Final Report, Element Energy

One thing is sure though, that in an evolving energy system flexibility will always have value. The value from each flexibility product is constantly changing, so propositions should seek to switch between several revenue streams in order to mitigate this risk. It is also clear that V2G will always be able to do significantly more than its Smart charging counterpart.

What about CHAdeMO and CCS?

CHAdeMo and CCS are the two key EV charging protocols, with CCS being the most common standard in Europe.

CHAdeMO is currently the only protocol that supports V2G. Currently the Nissan LEAF and e-NV200 are the only BEVs that support V2G and do so via the CHAdeMO standard.

However, across the large vehicle manufacturers we are not aware of any other models planned to include CHAdeMO in Europe. So, it is imperative to progress CCS to being fully V2G capable. Work is already starting in this area, with Indra now working on building a CCS V2G unit through the 'CCS V2X' project. Through the project they will be driving forwards the standard for CCS V2G.

Where to go to find out more?

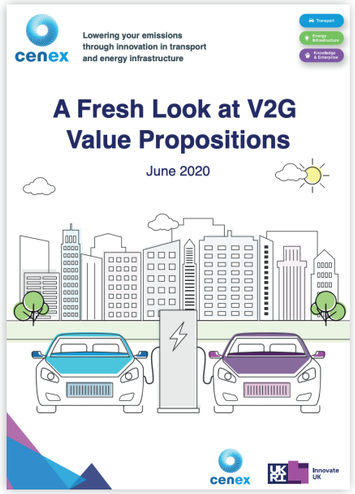
This paper draws from the learnings so far from Project Sciurus. Sciurus is part of the Vehicle-to-Grid (V2G) competition, funded by the Department for Business Energy and Industrial Strategy (BEIS) and the Office for Zero Emission Vehicles (OZEV), in partnership with Innovate UK, part of UK Research and Innovation.

The partners in the project are Cenex, OVO Energy, Nissan and Indra.

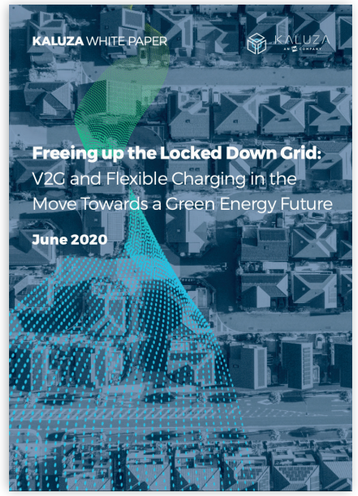
To find out more about the Sciurus project visit …
https://www.ovoenergy.com/electric-cars/vehicle-to-grid-charger

To find out more about V2G technology visit …
https://www.cenex.co.uk/energy-infrastructure/trials-and-demonstrators/vehicle-to-grid-v2g/

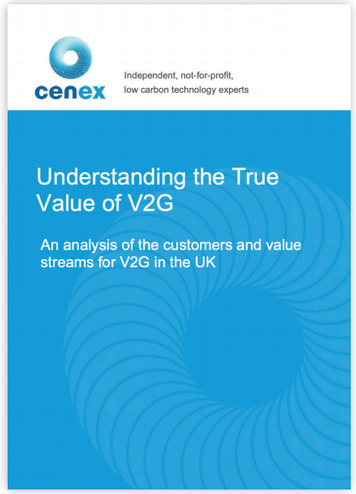
Further Reading



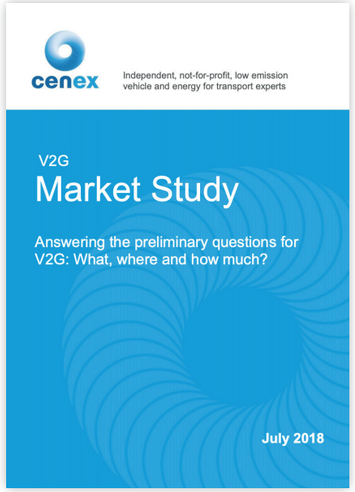
A Fresh look at V2G Value Propositions



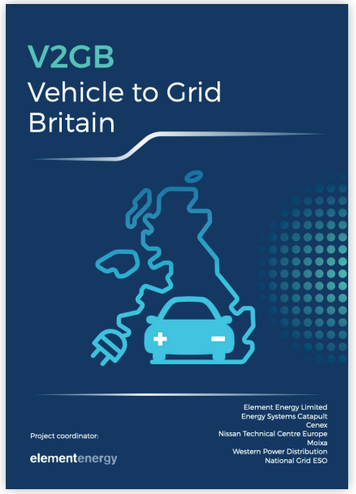
Freeing up the Locked Down Grid



Understanding the True Value of V2G



V2G Market Study



V2GB - Vehicle to Grid Britain

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You can find out more about our work on V2G, along with downloading a range of free, public reports, from our website:

www.cenex.co.uk

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