Innovate UK

Results of Competition: Innovation in Vehicle-to-Grid (V2G) Systems: Feasibility Studies

Competition Code: 1705_FS_TRANS_V2G

Total available funding is £2m from BEIS and OLEV

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
AGILE IMPRESSIONS LTD	Blockchain Enabled Vehicle to Local Grid (BEV2LG)	£94,233	£65,963
E-CAR CLUB LTD		£45,352	£22,676
GREEN RUNNING LIMITED		£76,557	£53,590

Project description - provided by applicants

At 40% EV market penetration, 32% of UK local electricity networks will require intervention, with an estimated cost of £2.2bn by 2050 (EA Technologies). Clusters of EVs, such as EV car clubs' hubs, have a more significant impact on the local grid, especially when looking at peak demand, harmonics and voltage violations. V2G has the potential to reduce low voltage network upgrade requirements. In today's perspective, DNOs have no ability to harness V2G to adjust load in localised areas to avoid network faults or support in recovery from network outage/black start circumstances. In order to meet the market need for a cross sector solution, Agile Impressions (AI), Green Running (GR) and E-Car Club (E-Car) seek to establish feasibility for a Blockchain Enabled Vehicle to Local Grid (BEV2LG), implementing GR's emerging blockchain technology in the e-mobility sector, where EC and AI have a strong record delivering business-minded innovation. BEV2LG will enable EV fleet owners to export electricity back to the grid when most needed by local grids and do billing, creating a platform in which EV fleet owners can provide grid balancing services to local networks operators (DNOs) through blockchain technology. This guarantees e-mobility to benefit from: high interoperability across stakeholders, secure permissioned interaction so that various stakeholders work on one value chain, no single point of failure (decentralized, transparent, redundant and secure), and pay-as-you-go microtransactions to be profitable (no middle man). This feasibility study validates the technical and commercial potential of BEV2LG, applying cutting edge technology to unlock V2G services to benefit local networks.

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UPSIDE ENERGY LTD	HAVEN - Home as a Virtual Energy Network	£98,875	£69,212
GOOD ENERGY LIMITED		£50,632	£25,316
HONDA MOTOR EUROPE LIMITED		£17,820	£8,910
University of Salford		£52,226	£52,226

Project description - provided by applicants
EV batteries can provide significant flexibility to the grid and hence value to the consumer, but this must be considered in the context of consumers' wider lifestyle and systems. HAVEN will examine the value that V2G and V2H (vehicle-to-home) enabled EVs can provide to consumers within the context of other energy storage systems (e.g. LI-Ion batteries attached to solar PV arrays; thermal storage via hot water tanks) in the home. HAVEN will address questions such as: * The value that V2G-enabled EVs can create by providing flexibility services to the system operator, distribution networks and energy suppliers. * How this value varies when EV batteries are combined with other home energy storage systems. * How value varies across different energy consumption and generation patterns, different driving and commute patterns, etc. * How value varies with different use cases for sharing energy between home energy systems. It will do this by creating robust models of a variety of home energy storage configurations, and using these to determine the value each configuration can create when providing services to the energy system. HAVEN will then test the models against the unique facility of the Salford Energy House (a Victorian terraced house in a climate-controlled chamber), ensuring that they robustly capture the dynamics of different use cases across a range of weather and other factors. This will ensure that the models and resulting consumer propositions accurately reflect the value that can be captured by consumers and the energy system in real world conditions. This will create a unique set of models demonstrating the value V2G-enabled EVs can create for consumers within the wider context of their homes and lifestyles. It will provide unique insight into potential customer propositions and business models for V2G, and also into the algorithms that must be developed to capture and exploit this value within Upside Energy's cloud service that orchestrates distributed energy storage resources and delivers their flexibility to the grid.

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ELEMENT ENERGY LIMITED	V2GB – Vehicle to Grid Britain	£67,261	£47,083
CENEX (CENTRE OF EXCELLENCE FOR LOW CARBON AND FUEL CELL TECHNOLOGIES)		£30,554	£30,554
ENERGY SYSTEMS CATAPULT LIMITED		£34,397	£34,397
MOIXA TECHNOLOGY LIMITED		£30,445	£21,311
NATIONAL GRID PLC		£9,083	£0
NISSAN MOTOR MANUFACTURING (UK) LIMITED		£35,476	£17,738
WESTERN POWER DISTRIBUTION PLC		£15,238	£0

Project description - provided by applicants
There is increasing concern as to whether electricity infrastructures, from generation to distribution, will be able to support the widespread deployment of electric vehicles. EV charging loads are unprecedented, and early UK trials showed that widespread _uncontrolled_ EV charging could double peak loads on distribution networks (CLNR). As more car companies announce plans to focus on EV drivetrains, the ramping up of this charging load could be very rapid indeed, challenging the stability and security of the electricity grid. This could require costly upgrades to networks, that will ultimately be passed on to customers and could become a roadblock for selling EVs. Controllable/dispatchable charging is an important first step but there are far greater market opportunities available if the full potential of the EV fleet is realised via Vehicle to Grid technology. The energy storage capacity of a future EV fleet would represent an energy asset of national significance. Studies by partners on this project have shown how EVs can stabilise grids, delay infrastructure investments, increase the deployment of variable Renewable Energy technologies on grids, reduce curtailment, lower grid carbon emissions, and provide low cost energy for driving, all without interrupting the service provided to the driver. The system flexibility provided by Vehicle to Grid (V2G) is vital to achieving these outcomes. As of today, there remain significant gaps in knowledge on potential V2G markets and revenue streams, competition with other technologies, driver behaviour and response to V2G, and commercial arrangements and legislative constraints. This feasibility study will address these knowledge gaps by: - Provide much needed insights on V2G markets and revenues longer term --focussing on derisking the sector by identifying the drivers for future markets (such as the deployment of Renewable energy technologies and reduction in grid inertia) and value (including competition from other sources of flexibility) - Deep dive to identify and derisk the early market opportunities which provide nascent V2G sector the opportunity to learn by doing while generating sustainable revenues. - A critical review of configurations of value chains and business models to identify those which perform well across dimensions including policy and regulation; market structures, and customer benefit. - Show how a sustainable V2G sector can sustainably build up from early demonstration projects to playing a vital role as a flexibility provider in a more efficient and decarbonised energy system.

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POWERVAULT LTD FRANKLIN EV LIMITED	The Smart Home Enabled Domestic Charge-point Solution	£141,603 £50,762	£99,122 £35,533
Project description - provided by applicants			
Ownership of electric vehicles (EVs) is significantly increasing within the UK with the number of new registrations increasing from 3,500 in 2013 to 107,000 in 2017\. In turn, this will place significant pressure on the demand for charge infrastructure as well as the grid network, whereby it is estimated that by 2025 up to 700,000 electricity users could suffer from blackouts due to the increased pressure on the grid, stemming from EV charging. In turn, Powervault, the UK's first provider of cost effective distributed battery energy storage solutions (BESS) to domestic homes (lowering consumers' electricity bills whilst reducing peak grid demand), and Franklin Energy, a UK based e-mobility charging provider that provides turnkey electric vehicle charging solutions, wish to form a partnership in order to supply the domestic market with truly intelligent charge-posts, which allow the export of energy from the EV to the home/grid by connecting to the BESS. This will have the key advantages of allowing for energy from the EV to be balanced against other sources of supply/demand within the household and reducing a household's reliance on the grid. This project is a feasibility study that seeks to develop technical specifications to allow the integration of a Franklin Energy charge point with Powervault BESS, as well as developing the business case for this offering, which will underpin future development of the concept.			

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ZERO CARBON MARINE LIMITED	Western Isles Consolidated V2G and RE Study	£64,141	£44,899
CENEX (CENTRE OF EXCELLENCE FOR LOW CARBON AND FUEL CELL TECHNOLOGIES)		£30,554	£30,554
E-CAR CLUB LTD		£75,575	£37,788
REGEN SW		£22,493	£22,493

Project description - provided by applicants

This study will assess the potential for islands to decarbonise their power and transport markets. The ultimate aim is to deploy V2G technology to make the islands totally self-sufficient for energy and maximise the export of zero carbon power through the interconnector to the mainland. The principal output of the project will be an optimised business model in support of a new business which combines energy and transport in a single product to customers at an attractive price. Subsidiary output includes software capable of signalling to connected EVs to charge or discharge in different scenarios.

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FLEXIBLE POWER SYSTEMS LTD	Integrated Energy Systems for Commercial Vehicles	£105,267	£73,687
Heriot-Watt University		£44,199	£44,199

Project description - provided by applicants
The commercial vehicle (CV) sector including HGVs, Light Vans, Buses and Coaches accounts for 34% of UK transport related CO2 emissions, globally HGVs contribute 7% emissions. They also impact air quality with about 39% of NOx and about 19% of PM2.5 emissions from transport coming from the sector, despite commercial vehicles accounting for less than 13% of the vehicles on the road. Electrification is one route to reduce the impact of this sector on the environment alongside route and roadmile optimisation, efficient driving programmes and retrofitting. CVs are a target for V2G because they: (i) congregate in large numbers at depots, (ii) schedule duty cycles in advance, (iii) have battery packs larger than those required for passenger vehicles and (iv) are owned by businesses who would be able to price battery life/energy revenue trade-offs if packaged appropriately. Whilst some projects have explored the feasibility of V2G for passenger vehicles, work in the CV space has been more limited because operators are risk averse and fleets are currently relatively small. Electrifying CVs is challenging; the distances they cover and vehicle mass are larger than those seen in the passenger car segment. Also because they congregate in large numbers, electrification can be curtailed by access to network infrastructure and their impacts on energy systems are complex. This project combines insights into CVs, logistics, technology development and energy markets with customer engagement to explore the role that electrification and V2G technology can play in tackling emissions from this sector. By pursuing a full stack of energy storage services, integrated with the site and network energy system and leveraging other CV operational efficiencies, we aim to deliver a business model for electrification to operators by matching vehicles and services to their needs. The key output of the project will be a deep understanding of customer perspectives and technology challenges alongside a set of viable business models (tested with all stakeholders) that can be replicated in the UK and abroad. A next step would be to demonstrate these models on some reference customer sites before wider roll out. There is also an opportunity to combine this exploration of the benefits of V2G in this sector with a more holistic piece of work seeking to reduce emissions from the sector being undertaken separately by Heriot Watt as part of its work with the Centre for Sustainable Road Freight (SRF) to develop CV sector specific business models.

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AVL POWERTRAIN UK LIMITED University of Warwick	BADGE - BAttery Degradation for Grid-connected Electric vehicles	£158,818 £66,154	£79,409 £66,154

Project description - provided by applicants
The vehicle-to-grid (V2G) technology emerged few years ago when the plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) gained in popularity and market share about 10 years ago. V2G technology defines the ability for a PHEV and BEV to draw energy from its battery in order to redistribute this energy to the grid. As a fact, vehicles are 90%-95% of the time parked, therefore battery are idling. V2G offers the opportunity to store energy within the vehicle's battery during off-peak hours and then provide electricity to the grid during peak hours in order to support the grid. It could also partly solve the issue of the renewable energy variable production using vehicle's battery as energy buffering. Studies and researches highlighted the ability of PHEV/BEV battery to support the grid and emphasized its benefits regarding peak shaving (technique to reduce electric peak consumption) and frequency regulation. Despite all these benefits, some other studies pointed out as main barrier for V2G adoption the risk of faster battery degradation. This project aims extend state-of-the-art V2G analysis tools and models by: (a) including within the decision-making framework an accurate estimate of battery degradation and (b) will create a smart data collection and management infrastructure to quantify key V2G metrics e.g. vehicle availability, battery energy level, battery health, grid energy requirements. This project will be achieved by the consortium composed of AVL Powertrain UK and Warwick University (WMG). The key innovation is to optimise the energy transfer between the car and grid by integrating real-time knowledge of battery performance and degradation. WMG will extend its previous research and will provide the mathematical model of battery performance/degradation while AVL will collect a big amount of real-world data and develop smart algorithm for the battery control. Real-time information related to V2G operation, such as battery level, charger availability, energy pricing, will be provided to the driver through a smart hub display prototype. This project could help the car manufacturers to develop their future batteries and its control based on this extended usage. The utilities/distribution companies will also be able to plan their future investment and policy. Government could adjust and/or create new incentives to be suitable for V2G application. Finally, the user could be informed through the dashboard about its vehicle capability for V2G purpose.

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E-CAR CLUB LTD	Project ENVINCE	£109,198	£54,599
HANGER19 LTD		£50,039	£35,027
Project description - provided by applicants			
With a changing market in the car club and on-demand services sector, there are new opportunities emerging with bespoke electric vehicles to meet specific transport challenges. Within the design of the vehicles, new charging approaches and standards are being explored. This feasibility study seeks to determine the opportunity and impact of V2G opportunities in different usage scenarios for these new technologies and highlight the new market opportunities they can accelerate through the additional V2G funding stream.			

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