



All images courtesy of Go-Ahead London

The Bus2Grid Project: Innovating hard and soft

The Bus2Grid project started in July 2018. Funded by the Department for Business Energy and Industrial Strategy (BEIS) and the Office for Zero Emission Vehicles (OZEV), with support from Innovate UK as a delivery partner, the project is designed to equip 28 state-of-the-art double decker buses, with technology capable of returning over 1MW of power to the grid.

The project partners consist of electric utility SSE Enterprise, bus manufacturer BYD, UK Power Networks and the University of Leeds. With support from energy optimisation technology provider Origami and hosted at bus operator Go-Ahead London's Northumberland Park depot where buses have already started transporting passengers around the city.



What problem are we solving?

The electricity system is changing. While the UK used to rely on large, fossil fuelled power stations, more renewables like wind and solar are fulfilling more demand than ever before. This means some fossil power stations are closing, and the services they used to provide for keeping the lights on need to be provided by other assets. This is where vehicle-to-grid comes in. Most of the value of a vehicle battery is in the transport it enables. If the battery can be used carefully by the electricity system when the vehicle is charging, then it becomes a low cost way to access 'flexible' power.

Vehicle batteries that can export power can do some of the jobs fossil power stations used to do, smoothing second by second and minute by minute fluctuations on the electricity grid.

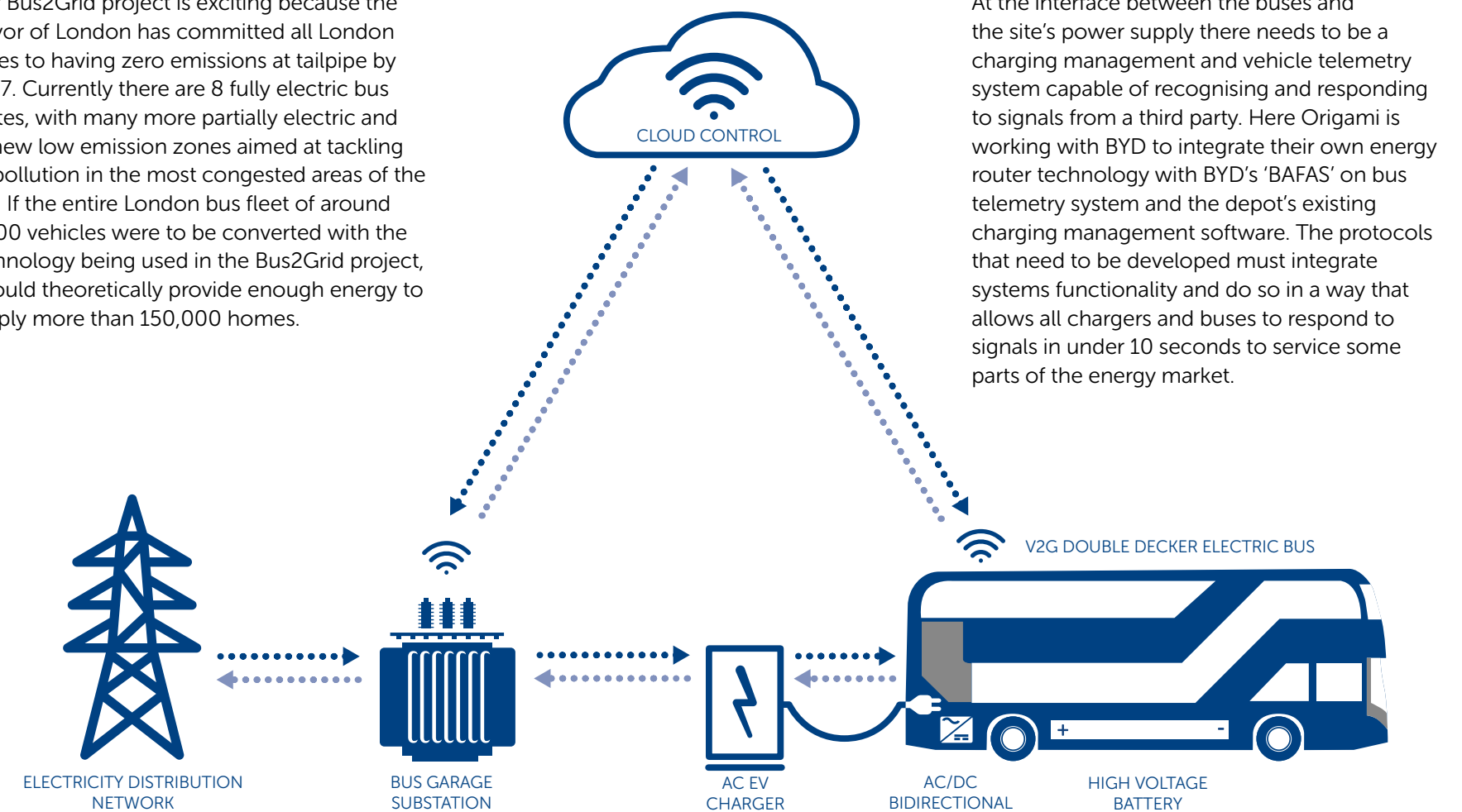
What innovation is needed?

Unlike other vehicle to grid trials we are working with 28 heavy commercial vehicles all connected on one site under one owner. Heavy vehicles such as these can charge at 80kW and discharge at 40kW meaning the volume of response from 28 buses can be more than 3MW with demand side response under certain conditions. Rather than having to recruit hundreds of private vehicle owners through hundreds of electricity tariffs, this approach means one set of commercial parties can contract one significant volume of resource to the energy system operator. To do vehicle-to-grid at this scale though needs several strands of innovation to come together, both hard engineering and softer process and business model change.

Hard innovation

On the hard engineering side, this volume of export power at one site means the bus garage needs to be treated more like a generator on the system. The buses need to make sure their power export is safe, and reliable enough to protect the surrounding power grid. This means the substations and infrastructure around the garage need upgrading to handle a larger power import and have the hardware in place to deal with a two-way power flow. The costs associated with this work needs to be set against the revenues that can be made from participating in the energy market. Further, work needs to be undertaken on the power characteristics of the buses and ensure they are compliant with 'G99' standards, a certification used for connecting generation projects. This requires the bus manufacturer to design systems to the standards of power generation as well as transport services.

Our Bus2Grid project is exciting because the Mayor of London has committed all London buses to having zero emissions at tailpipe by 2037. Currently there are 8 fully electric bus routes, with many more partially electric and 12 new low emission zones aimed at tackling air pollution in the most congested areas of the city. If the entire London bus fleet of around 9,000 vehicles were to be converted with the technology being used in the Bus2Grid project, it could theoretically provide enough energy to supply more than 150,000 homes.



Schematic design for Bus2Grid

Soft innovation

On the softer side of innovation there is a need for new types of partners to work together and find new business models and value sharing principles. The project has facilitated a process of learning between the transport led and energy led stakeholders in the project. Here the needs of the vehicle owner Go Ahead, must take precedence. Each bus needs to be at a set state of charge to leave the depot in a morning and run the routes contracted by Transport for London. The primary role of most of the on-site hardware is to fulfil this need. After this, the site needs to remain within limits set out by the grid provider, UK Power Networks, in the site connection agreement. Once these conditions are satisfied, and the hardware development and installation is complete and tested, Origami's systems can be used to enable SSE to bid into the Electricity System Operator to fulfil energy services.

Observing the constraints above it is possible to calculate the available flexibility window. When it is clear what this flexibility window looks like, then BYD can model the impact on the battery and power handling equipment on the buses that may result from servicing this market, and ensure a risk sharing agreement is in place between manufacturer and buyer.

In a business model development workshop in May 2019 run by the University of Leeds, the project partners identified no fewer than nine commercial contracts are affected by this process, moving from standard electric buses to vehicle to grid capable buses. Each of these contracts has varying lengths and covers existing commercial activities. In this way the hard and soft innovation elements need to co-evolve, making communications and project management as important an element of innovation as the development of new software or power handling equipment.



Who benefits if we are successful?

By reducing the volume of fossil fuelled power stations that satisfy energy system flexibility, we reduce greenhouse gas emissions from the UK power sector. The bus operator is able to offer more competitive contracts and could ultimately lower costs for passengers because they are benefitting from energy contracts they can make some revenue from. Because the diesel to electric switch becomes more attractive, city dwellers benefit from better air quality. Finally, by bringing together engineering, commercial, manufacturing and software innovation, this trial builds the capacity of the UK to maximise the benefits of a smart energy revolution.

These benefits have been estimated at over £40bn in Great Britain by 2050. These savings to the UK economy come from reducing need for traditional heavy engineering solutions, maximising the use of renewable energy, and combining smarter systems with better forecasting and system planning.

Bus2Grid is part of 21 V2G projects awarded in 2018 by Innovate UK in a globally significant £30m innovation trial. By the end of the project, London and other UK cities will be in pole position for developing and expanding the benefits of vehicle to grid technologies.

Partners

SSE Enterprise: www.sseutilitiesolutions.co.uk/
BYD: www.byd.com/en/index.html
UK Power Networks: <https://innovation.ukpowernetworks.co.uk/>
University of Leeds: www.leeds.ac.uk/

Support from

Origami: www.origamienergy.com/
Go-Ahead London: www.goaheadlondon.com/
Transport for London: tfl.gov.uk/

