Charged with potential: Lessons from Utrecht Energized vehicle-to-grid project

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1. Introduction

In June 2025, the Dutch city of Utrecht launched 'Utrecht Energized', Europe's first large-scale vehicle-to-grid car-sharing scheme. Deploying 150 bidirectional electric vehicles (EVs), with plans to scale to 500, the initiative uses shared EVs as distributed energy assets, storing surplus solar power and returning it to the local distribution network during periods of peak demand. The launch marked a significant milestone in the development of vehicle-to-grid (V2G) technology, and the culmination of over a decade of research and development involving regional and municipal authorities, the distribution system operator (DSO), the private sector, universities and entrepreneurs.

This policy paper reviews the development of V2G in Utrecht. It draws on academic and technical literature, interviews with development partners, and engagement with stakeholders at seminars, conferences, and site visits. The paper considers how and why the idea of combining V2G and car-sharing came about in Utrecht, partners and their roles, the market and regulatory context, and the opportunities and constraints to developing V2G in other cities. The final section considers what policymakers and practitioners can learn from Utrecht's experience of developing and implementing V2G.

2. V2G context

Across the world low carbon flexibility to balance electricity supply and demand is becoming increasingly vital as energy systems transition towards renewable energy resources. A range of clean flexibility sources are available, including grid-scale options like batteries, pumped hydro and interconnectors, through to smaller, distributed energy resources on the demand side, such as PV and batteries, EVs and heat pumps.

Globally, EVs are expected to account for 40% of vehicle sales by 2030, with the number of vehicles increasing to 250million. The global EV fleet consumed around 180 TWh of electricity in 2024, almost 60% more than the previous year, and this demand could increase more than fourfold to 780 TWh by 2030 [1]. As EV adoption accelerates, V2G technology can act as a critical tool for managing the electricity system, enabling the vehicle batteries to act as distributed storage that can absorb surplus renewable generation, reduce peak demand, defer grid reinforcement, and help balance electricity networks. This could give them a significant role in supporting low carbon, renewable dominated energy systems. For example, within Great Britain (GB)[1], modelling from NESO, the system operator, suggests that smart charging of EVs and V2G will provide around 50GW of flexible capacity, nearly 25% of the clean flexibility required in 2050 [2].

[1] We refer to both Great Britain and the United Kingdom depending on which jurisdiction initiatives apply to. For example NESO is the system operator for Great Britain (GB), covering England, Scotland, and Wales but not Northern Ireland.

Both the United Kingdom (UK) and Netherlands are pursuing ambitious zero emission vehicle targets; in the UK through annually escalating zero emission vehicle (ZEV) sales targets[2], and in the Netherlands through a government commitment to all new passenger car sales being zero-emissions by 2030 [3] [4]. Like many Dutch cities, Utrecht's electricity grid is severely congested and parking for private vehicles is limited; together these issues have been the impetus for the development of car-sharing, smart EV charging and vehicle-to-grid (V2G) using car-share EVs.

3. Utrecht Energized – car-share V2G

Utrecht Energized (UE) is an EV car-sharing service in Utrecht, which forms part of the fleet run by MyWheels, the largest car-sharing provider in the Netherlands [5]. At its launch in 2025, UE had a fleet of 50 V2G-capable, Renault 5 E-tech Electric (R5) cars. This has since grown to 150 cars with plans to double to 300 in the spring of 2026 and "*up to 500*" (including other Renault models) by the end of the year [6]. The vehicles are booked for hourly, daily or longer rentals via the MyWheels app with fees based on duration and distance travelled. Each car comes with a tethered charging cable, and each dedicated parking bay has a 7kW, AC, V2G-capable charge point. Charging and (V2G) discharging of UE cars is managed remotely by We Drive Solar, an Utrecht company and developer of V2G charging hardware and software, using their own systems which integrate with the MyWheels booking system. The charging strategy is designed to maximise revenue from energy arbitrage without inducing undue wear on the 52kWh traction battery in each car. The hourly cost of electricity is taken as a proxy for grid congestion; it is assumed that when the unit cost of electricity is high the grid is likely to be congested and vice versa (discussed below). Initial data suggests cost and congestion align about 95% of the time. Charging/discharging of vehicles is governed by a number of factors including: the start time of the next booking; state of charge when a car is returned; and the unit cost of electricity. National data on the day-ahead, unit cost of electricity is provided by Epex Spot in hourly increments [7]. Broadly, when the electricity price is low the system will look to charge connected cars, and discharge them when the price is high (allowing for other factors including booking start times), thereby generating revenue, and easing grid congestion. In addition to trading in the wholesale market, Utrecht Energized is using the flexibility of its fleet to generate additional revenue by providing

Figure 1: LomboxNet AC-V2G EV charging post, Utrecht. Post has two power outlets and can charge/discharge (in any combination) two cars simultaneously at 7kW.

[2] The ZEV mandate initially applied only to Great Britain but the Northern Irish Assembly approved its extension to Northern Ireland from 1st January 2025.

grid congestion services, and is exploring other options including aFRR[3] (automatic frequency restoration reserve).

To limit battery degradation the State of Charge (SoC) is maintained between 20% and 80% during V2G cycles, though cars start each booking with a full battery. Any degradation in battery health is covered under Renault's standard battery warrantee (80% capacity remaining after 8 years), though there is an undisclosed limit on the total amount of energy supplied to the distribution network by each vehicle, to which We Drive Solar adheres. In the first five months since launch, more than 65,000kWh of electricity was discharged to the distribution network by 50 cars (an average of 1,300kWh and 118 hours of discharge per car) with peak discharge power from the fleet of 300kW [8]. Utrecht Energized uses AC-V2G exclusively, meaning the DC to AC inverters are in the vehicles, which supply AC current to the charge points connected to the distribution network (Box 1). Communication between the cars and chargers follows the 15118-20 protocol[4] and communication between the charge point and charge point controller uses the Open Charge Point Protocol (OCCP) [9].

> Box 1: AC versus DC vehicle-to-grid
>
> For an EV to supply electricity to an electrical distribution network, the DC output from the car's traction battery must be converted to an AC current which must synchronize with the network supply. This requires a DC to AC inverter which is either fitted in the vehicle or the charge point. For AC V2G the inverter is in the car, however, AC-V2G charger points still require appropriate software and hardware to ensure vehicle-charger-grid compatibility and to meet the grid codes which set the technical standards and parameters for a distribution network.

3.1 Utrecht Energized partners

We Drive Solar has been a key instigator of V2G and Utrecht Energized. Established in 2016 by a local entrepreneur Robin Berg, it was set-up as an EV car-sharing scheme to utilise surplus electricity generated by solar PV in the city. It has since become a developer and supplier of V2G-capable EV chargers and control software, for homes, businesses and the public sector [10]. In 2019 it ran a V2G trial in Utrecht using modified Renault ZOEs and AC chargers, before partnering with **Koolen Industries** in 2023 [11] to develop AC-V2G EV chargers. It is now working with other Dutch cities on implementing similar V2G car-sharing schemes. We Drive Solar is the charge point operator (CPO) and aggregator[5] for Utrecht Energized, but

[3] automatic Frequency Restoration Reserve (aFRR), is a reserve balancing service used to help keep the frequency of the grid stable. It is also known as secondary reserve.

[4] ISO standard 15118-20:2022 Road vehicles — Vehicle to grid communication interface. This extended the previous 15118-2 protocol that enabled Plug and Charge, by adding V2G capability.

[5] For commercial reasons, V2G charge points for Utrecht Energized are supplied and operated by LomboxNet which delivers internet services and solar power, rather than We Drive Solar. LomboxNet was founded and is owned by Robin Berg.

elsewhere it will only tender to supply V2G charge points and licence its control software, with charge point operation and aggregation provided by other parties.

Last Mile Solutions develops and provides EV charging and energy management software, including the software used in Utrecht Energized. It has worked on the development of EV charging standards since 2007 [12] and has collaborated with We Drive Solar since 2015 when it worked on the V2G pilot, and provided the energy management platform that connected charging stations to the distribution network.

MyWheels manages and operates the car sharing aspects of Utrecht Energized including vehicle booking, billing and back-office services such as vehicle registrations, insurance, servicing, cleaning and repairs.

Renault supplies the EVs, R5 E-Techs equipped with its Mobilize V2G toolkit, for Utrecht Energized and has been working with We Drive Solar since the 2019 pilot [13]. **Mobilize** is a Renault sub-brand which has developed the V2G hardware/software toolkit that gives Renault vehicles V2G capability when connected to a Renault-compatible AC charger [14]. Mobilize provides other services including financing, insurance, payments, fleet management, energy, vehicle maintenance and refurbishment via its integrated technological platform.

ELAAD (also known as ElaadNL) is a not-for-profit initiative funded by the Dutch grid operators. It was set up in 2009 to investigate the impact of EVs on energy networks and to provide testing, and knowledge transfer via its innovation centre in Arnhem. With DSO funding, supplemented by EU programmes, it provides Original Equipment Manufacturers (OEMs) and charge point providers with free testing, certification and research services including on smart charging, solar PV, heat pumps, HEMS[6], power quality, logistics, behavioural research, interoperability, technical protocols and quality assurance as well as knowledge sharing and training [15]. Test data remain the property of OEMs and equipment suppliers, but ELAAD publishes technical and policy guidance based on its research findings. It is continually expanding its knowledge base through the addition of EV chargers and supply equipment it has tested. ELAAD led **SCALE**[7], a Horizon Europe Programme (2022-25) with 29 consortium partners comprising European cities, OEMs, universities and knowledge partners and charging infrastructure companies [16]. The programme's aims included the development of an open system architecture for smart charging and V2X, reducing the need for grid reinforcement by at least 50%, and preparing for the mass-market roll-out of smart charging and V2X by deploying a user centric approach and ensuring that new EV chargers are V2X enabled from 2025.

The Municipality of Utrecht is the city council and planning authority and has been a key participant in the development of V2G, including in the trials that preceded Utrecht Energized. It is responsible for granting

[6] Home Energy Management Systems

[7] SCALE: Smart Charging ALignment for Europe. The programme was funded by the European Union Horizon Europe Research and Innovation Programme. Pilot sites were in Oslo (NO), Rotterdam/Utrecht (NL), Eindhoven (NL), oulouse (FR), Greater Munich Area (GER), Budapest/Debrecen (HU), and Gothenburg (SE)

planning permission for dedicated parking bays and charge points in the city and for setting the technical procurement specification for EV chargers, which includes a requirement for these to be V2G capable. It has developed a comprehensive EV charging infrastructure plan to 2030 based on mapping of EV charging requirements and grid congestion at a neighbourhood and sub-station level [17]. The municipality has also commissioned static battery energy storage in the city: 750kW in 2018, and a further 600kW in 2020 [18].

The Regional Development Agency (ROM) ('Regionale Ontwikkelingsmaatschappij') exists to support start-ups, businesses and projects that contribute to the economic development of the Utrecht region [19]. It supported the early development of V2G in Utrecht, and provided funding to We Drive Solar for its initial V2G pilot.

Stedin is a Dutch DSO and a public utility owned by 44 municipalities and the Dutch state [20]. It is a founder and financial sponsor of ELAAD and has been a leading supporter in the development of V2G in Utrecht, as well as promoting the role of smart charging and V2G in maximising the efficient use of distribution networks. Stedin serves over 2.3 million householders and businesses and manages electricity and gas grids in North Holland, Zeeland, Utrecht and South Holland [21]. Between 2023 and 2030 it plans to invest at least €8 billion in expanding grid capacity.

Utrecht University, and Delft University of Technology (TU Delft) have contributed to the development of Utrecht Energized [22], including through **Utrecht Sustainability Institute** [23], an independent research institute spun-off from Utrecht University. In 2021, Utrecht University and Utrecht Sustainability Institute headed-up **ROBUST** (Research into the robust electricity system of the future) [24] a research project[8] aiming to reduce grid congestion and provide flexibility in national energy markets. In 2021 Utrecht University also collaborated with Stedin on the **FLEET** project: a large-scale evaluation of the impact of dynamic grid tariffs on EV charging in Utrecht, using more than 300 EV charge points operated by We Drive Solar [25]. Utrecht University was also a consortium partner in the SCALE programme led by ELAADNL alongside Renault, We Drive Solar, the Municipality of Utrecht and others [26].

4. Drivers of V2G and grid flexibility services

4.1 Grid congestion

Grid congestion is a widespread challenge across the Netherlands and a key driver of flexibility services and V2G development in Utrecht (Figure 2). In October 2023, Rob Jetten, Minister of Climate and Energy described the electricity grid in all provinces as being "*largely full, probably full, or almost full*"[9] [27,28], and concern is such that the Dutch Government has run a TV advert encouraging people to reduce

[8] With the cities of Arnhem and Utrecht, and project partners TU Delft, HU University of Applied Sciences Utrecht, We Drive Solar, Stedin, SMART Solar Charing BV, ELAADNL, Edmiu, and Enervalis.

[9] Translation of a letter from the Minister to the President of the House of Representatives, from Dutch to English.

electricity consumption during peak hours [29]. The IEA estimated that within the Netherlands in 2024, 10,000 large users and 7,500 large generation projects (greater than household scale) were on the waiting list for new and higher capacity connections [30]. This is having a knock-on impact on applications for new housing and industrial development, and increasing costs to consumers as a result of grid charges levied by TenneT (the national electricity transmission system operator).

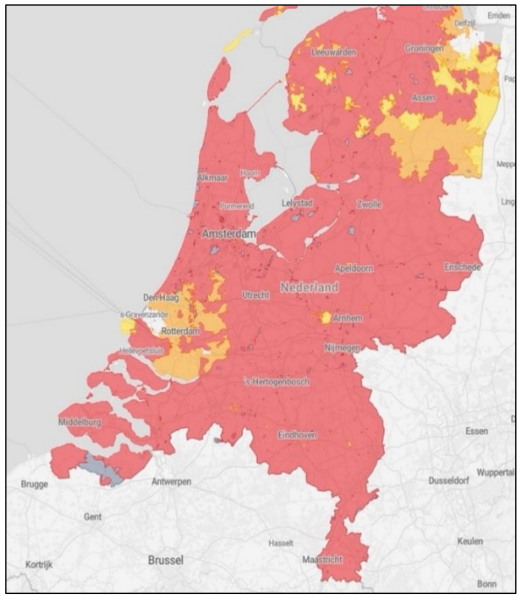

Figure 2: grid capacity constraints on regional and transmission networks 2025 (Source: Netbeheer Nederland- data.partnersinenergie.nl) [76].

On the supply-side, the high percentage share of power generation from solar PV and wind (48% in 2024 [31]) is contributing to congestion. The Netherlands has the highest solar PV capacity per capita in Europe at 1,336W per person, only slightly behind Australia[10] [32] and in Utrecht 35% of buildings are estimated to have solar PV. In May 2025 national solar PV output peaked at 26GW at a time when demand was 15GW [6]. Without mitigation, the projected expansion of wind capacity will also exacerbate congestion. Existing wind capacity of 11.8GW (40% of which is off-shore [33]) is planned to almost double by 2032/33 to 21GW [34,35]. On the demand side, the electrification of heat in existing buildings, industrial processes, and new housing [27] is increasing demand ahead of projections in some parts of the country. In the port region of Rotterdam for example, the predicted demand in 2030 was reached in 2022 [36]. Demand from EVs is also a contributory factor. In 2024 the Netherlands had highest number of EV charge points of any country in Europe[11], the highest number of chargers per capita, and per 100km of highway [37]. Stedin calculates that on average for each EV charging station that is 'off' during the evening peak, one new home can be connected to the network [38]. Conversely, in some urban areas 20% of new capacity planned between 2024 and 2030 will be absorbed by new, on-street EV charging stations.

In response the Dutch government launched the National Grid Congestion Action Plan (landelijk actieprogramma) (LAN) in December 2022 [30,39] with the objectives of accelerating grid extensions, optimising existing grid capacity, and promoting flexible consumption. TenneT has produced a publicly available capacity map which is updated quarterly, and is conducting 'congestion studies' into the use of system flexibility to reduce congestion at peak times, focusing on the port area of Rotterdam, and

[10] Australia: 1,426W per person. For comparison the United Kingdom (UK) is ranked 12th at 300W per person.

[11] The UK is included in this analysis.

Flevopolder, Gelderland, Utrecht and Drenthe [40]. It also ran an Open Innovation Program inviting ideas and solutions which identified three projects for further investigation: Siemens Energy - Expansion of grid capacity using Dynamic Asset Rating; KrakenFlex - Digitization of the Dutch network through intelligent flexibility[12], and N-Side: Probabilistic congestion forecasting for grid operators [41]. TenneT is working on the delivery of these initiatives with these partners [42].

4.2 Partnership working and determined disruptors

The immediate and future impacts of grid congestion provide a clear rationale for developing flexibility measures, such as V2G, that can free up grid capacity in Utrecht. However, this alone does not explain how the city has been able to take V2G from a concept to an operational project, despite technical and regulatory challenges. In Utrecht long-term collaboration between partner organisations and the presence of committed individuals to initiate and maintain momentum has been pivotal in driving development. Public, private and academic development partnerships are not unusual, but what is notable in this case is the extent to which the partners have coalesced around a shared problem (grid congestion), and common solution (V2G integrated with car-share EVs). Overall, an openness to disruptive ideas and solutions, and a long-term commitment to innovation and experimentation have been significant in the development of Utrecht Energized. In particular, the presence of ‘determined disruptors’ – committed, enthusiastic and influential people in key leadership roles – has been crucial to building support *within* and *between* partner organizations and maintaining a flexible approach to overcoming obstacles that might otherwise have derailed progress.

V2G combined with car-sharing is a novel solution to grid congestion and the multi-faceted nature of this approach, combined with public sector risk aversion, could easily have resulted in V2G car-sharing being marginalized in favour of more conventional solutions. However, the municipality and DSO both appear to have embraced the potential of V2G. The business model for ELAAD, which funds and supports private sector innovation and learning on V2G is also innovative and unusual, allowing OEMs and charge point providers from the Netherlands and beyond to test their equipment for free.

4.3 Car sharing, EVs and low emissions zones

Car-sharing meets a small, if increasing fraction of overall mobility requirements in the Netherlands. It is estimated that 2% of the population used a shared car between 2017 and 2020 [43] rising to 3.7% in 2025 and forecast to reach 4% by 2030 [44]. Much of the policy and regulation to support car-sharing is delivered locally through initiatives such as parking allocation, and in Utrecht, charging bays for shared cars,

[12] Kraken Flex, formerly ‘Upside’ has been part of the Octopus Energy Group since November 2020. Octopus describe it as a “a cloud-based platform that controls distributed energy assets with machine learning and artificial intelligence to match supply and demand” designed to help electricity grids deal with volatile supply from renewable energy generation assets [73] .

restricting parking standards for new development, and/or requiring new development to provide bays for shared cars. Under the Dutch Climate Agreement all new passenger cars must be zero emission by 2030. Though some of the previous measures brought in to stimulate take-up of EVs are now being phased down or out as the market matures [45], local incentives remain. For example, home owners' associations can apply for a grant for advice (including a site inspection) for installing EV charging infrastructure [46], and in almost all municipalities (including Utrecht) car owners who do not have their own parking space can request a free (to install) public charging station [47] [48]. Low emission zones (LEZ) known as milieuzone and zero emission zones (ZEZs) are also intended to encourage the transition to EVs as well as improving air quality. LEZs apply to diesel vehicles (based on Euro standards), and cities choose which class of vehicle is restricted. Since January 2025 Dutch municipalities have also been able to designate urban zero emission zones meaning that only electric or hydrogen fuelled vans or trucks are permitted to enter the zone [49]. As of January 2025, fifteen cities including Utrecht, had established ZEZs with a further fourteen planned between 2025 and 2030.

4.4 Net metering, energy tariffs and infrastructure investment

Between 2013 and 2024 grid connected PV in the Netherlands increased 33-fold from 739MW to 24,359MW [31]. This huge expansion followed a series of policy initiatives, coupled with the progressive reduction in the cost of PV. Since 2004, for example, householders and small businesses have been eligible for net metering ('salderingsregeling') and able to offset their energy consumption with the energy generated from solar PV on a one-to-one basis[13] [50]. Householders have also been able to reclaim all of the VAT on solar PV levied at 21%. Companies and not-for-profit organisations not eligible for net metering can apply for funding under the Sustainable Energy Production and Climate Transition Incentive Scheme (SDE++)[14]. Net metering is scheduled to be abolished on 1st January 2027, after which compensation for energy exported to the grid will be set by energy suppliers. Applications for the SDE++ closed in November 2025, and from January 2027 will be replaced with a two-way, contracts for difference (CfD) support scheme for onshore renewables [51].

Prior to the introduction of a new Dutch Energy Act (Energiewet) on 1st January 2026 Dutch electricity suppliers were not *required* to offer customers dynamic tariffs, though some of the large suppliers did so from 2023[15]. Typically, dynamic electricity tariffs are based on hourly, day-ahead market prices (EPEX Spot)

[13] Meaning a household or small business generating 3000kWh per annum and consuming 5000kWh per annum would only pay for the difference: 2000kWh. Most energy suppliers charge a 'feed-in' fee which is levied per kWh exported to the grid to cover administration costs.

[14] This provides a subsidy for periods of 12 or 15 years (dependent on the technology), for the 'unprofitable component' of the renewable technology. [74]

[15] Suppliers offering dynamic tariffs include Zonneplan, Tibber, ANWB Energie, Vandebronoffer and Frank Energie. Eneco was the first large supplier to do so in 2023 with its Eneco Dynamisch tariff.

[52], with gas prices set daily. However, in 2025 digital energy provider Tibber[16] announced it would offer customers with a suitable smart-meter, 15-minute pricing [53]. Smart meter rollout in the Netherlands began in 2014 and by 2025 approximately 90% of Dutch householders had a smart meter [54].

As net metering comes to an end, flexible users or ‘flexumers’ (users able to store and time-shift their consumption, and production of electricity) are expected to provide increasing amounts of system flexibility [55]. GridX[17] for example, estimates that by 2035 Dutch households could provide 28TWh of shiftable demand through Home Energy Management Systems (HEMS) [56]. HEMS connect and control multiple services such as residential heating, smart charging, and V2G to provide system flexibility by consuming or supplying electricity as required to balance the system [57]. This includes ‘implicit’ flexibility such as Time-of-Use tariffs and ‘explicit’ system-level flexibility in ancillary and balancing markets. Aided by high smart meter deployment, aggregators can consolidate and stack HEMS flexibility and generate revenue by trading this in balancing markets via platforms such as GOPACS (Grid Operators Platform for Ancillary Services) [58]. GOPACS was set up by TenneT the Dutch TSO and regional DSOs to act as a marketplace for congestion management ancillary services [59]. It is not a trading platform, but provides insight into where and when grid operators expect congestion, flexibility volumes required, and which bids have been activated. It links to trading exchanges like ETPA (Energy Trading Platform Amsterdam) and EPEX SPOT trading platforms, allowing market participants to align their bids effectively and supporting grid operators to coordinate flexibility and ensure actions do not cause problems elsewhere on the grid. As European local flexibility markets mature household savings and revenues will become clearer [60]. GridX estimates that participating Dutch consumers could earn up to €6 per day per system [56].

5. Barriers and blockers to V2G rollout

The experience of Utrecht Energized suggests there are two barriers that will need to addressed if V2G is to be developed at scale. First, grid codes (Box 2) need to be harmonised and compliance processes simplified, and second, OEMs will need to be confident that any investment in V2G hardware, software and regulatory compliance will generate a sufficient return to be a viable business proposition.

5.1 Grid code compliance

At present grid codes can vary by country, region and sometimes DSO area, so for an OEM to produce an EV that is universally V2G compliant it would need to demonstrate compliance for each jurisdiction. This is made more difficult by the complex nature of the technical specifications themselves, absence of a common format, and variation in scope. Demonstrating compliance can be lengthy, taking 6 to 12 months or more. The partners developing Utrecht Energized managed to simplify and shorten this process by

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[16] https://tibber.com/en/about-us

[17] gridX (head office in Munich) provides a range of energy management services for residential and e-mobility distributed energy resources.

refining the scope of the specification, and accepting evidence of compliance in other jurisdictions. Though this was a pragmatic work-around it is not a solution for OEMs wanting pan-European or global compliance for their vehicles.

The EU has recognized the need for grid code harmonisation and in 2022 proposed that the Agency for the Cooperation of Energy Regulators (ACER) expand the existing set of European grid codes to include the connection of EVs and EV supply equipment with the intention of harmonising requirements across the EU [61]. However, EU regulations on harmonised codes are not expected to be introduced until 2028 [62] and mandatory compliance not before 2030 [63].

Box 2 - Grid codes
Grid codes refer to the detailed technical standards that define the performance criteria and behaviour of energy supply equipment connected to an electricity distribution network. This includes EVs and charge points supplying electricity to the distribution network.

The codes define technical standards such as frequency and voltage, and safety standards and behaviours. When an EV connects to a distribution network it must know its location, and have been certified as compliant with the relevant grid codes for that location before it can start supplying energy to the network.

5.2 OEMs – the V2G business model

Many vehicle OEMs have been reluctant to commit to bi-directional charging or to favour AC or DC V2G, preferring to see how the market develops. Renault's commitment to rolling out AC-V2G is therefore notable, as is the decision to focus its first V2G offering at the affordable rather than premium end of its product range, where development and compliance costs would be more easily absorbed. Their rationale for developing V2G appears to be as a part of a broader marketing strategy, to incentivise customers to adopt to broader home energy and 'vehicle as a service' products delivered via its Mobilize brand (Box 3). Other OEMs including Hyundai, Volvo, Polestar, and Jaguar Land Rover are considering similar propositions [64]. In June 2025 Octopus Energy launched its Powerpack Bundle to UK customers comprising the lease of a BYD Dolphin, Zaptec Pro V2G charger, and a smart tariff [65], with free home-charging during the lease period (subject to mileage limits)[18]. For legacy OEMs the bundling

Box 3 - Mobilize Power
Customers in France with a compatible Renault EV (such as the Renault 5), a Mobilize Home Charger, and a Mobilize electricity contract can sign-up to Mobilize Power [77]. This gives a 10% discount on the unit rate for electricity, fixed rate for 1 year and 100% green electricity, plus potential to generate 'V2G hours earnings' by leaving the car connected to the charger. Renault give the example of a household using 6,500kWh of electricity per year, plus an EV using 1,600kWh per year, reducing their monthly payment from €130.80 to €103.90 for a car connected to the Mobilize Home Chargers 14 hours per day.

[18] Octopus state that customers need to be able to plug in for 12hours per day, 20 days per month, and charge less than 210kWh per month to stay on the Power Pack tariff [75].

together of domestic energy and mobility services into a consumer package may be a radical departure from traditional sales models, and it is not yet certain if it will be replicated across the sector, or how costs and revenues will be allocated between users and service providers. However, as the servicing and maintenance requirements for EVs are significantly less than those of combustion vehicles it may offer one means of addressing reductions in after-sales revenues and of building and maintaining a customer base.

6. Lessons for V2G from Utrecht Energized

6.1 Grid congestion drives innovation, but early intervention leaves scope for lowest cost solutions

Grid congestion has been a key driver for the development of V2G in Utrecht. As renewable generation grows, and transport and heat largely electrify, an increasing number of locations are likely to experience similar pressures. Utrecht's experience highlights the value of early intelligence gathering to develop a detailed and granular picture of current and future demand and grid constraints. This gives DSOs, municipalities, and communities the opportunity to develop the most appropriate, immediate and lowest cost solutions including V2G, community scale battery storage and behind the meter solutions, and avoid unnecessary infrastructure costs and investment. In Great Britain local and regional actors are increasingly involved in energy system planning[19] and experience in Utrecht could offer lessons on the development of geo-spatial data sharing and multi-actor collaborations.

6.2 V2G has developed to the point where it can provide grid flexibility services at scale

The 'learning by doing' approach of Utrecht Energized suggests that from a technical and regulatory standpoint V2G can deliver scalable grid-flexibility services using commercially available technology. The combination of V2G and car-sharing could provide a template that other cities could replicate or adapt, as is already happening in the Netherlands. The underlying approach of using EVs with AC-V2G capability and AC chargers, and charging-control software could also be applied to other fleets, and to EVs in private ownership with extended access to a compatible charge point. DSOs/DNOs seeking to increase system flexibility in response to grid congestion should consider what role V2G can play in the overall mix, and municipalities with responsibility for EV charging should plan to incorporate V2G capability into infrastructure programmes through their procurement frameworks.

6.3 Harmonised grid-codes are essential for V2G deployment at scale.

Utrecht's pragmatic and flexible approach to demonstrating vehicle and charge-point compliance with the necessary grid-codes has been highly effective in implementing V2G in the city. However, it is unrealistic for

[19] In GB the system operator is developing eleven whole system, net-zero-aligned Regional Energy Strategic Plans (RESPs) across England, Scotland and Wales. Increasingly local authority level energy planning is also taking place via Local Area Energy Planning (LAEP) or Local Heat and Energy Efficiency Strategies and Plans (LHEES).

OEMs and charge-point providers to repeat this approach in every jurisdiction in Europe. At present, grid-code compliance is a major barrier to the roll-out of V2G by OEMs whether delivered via EV fleets or private vehicles. The EU's proposal for harmonised grid-codes by 2028 should help to mitigate this, provided validation can be passported across jurisdictions. Countries outside the EU, will need to decide whether it is preferable to align with European V2G grid codes or implement their own. Evidence from Utrecht suggests that for OEMs, the cost and time needed to comply with bespoke codes is a significant factor in deciding if and when to commit to V2G. In the UK the Government is expected to align with the EU and require new and renovated private and public EV chargers to comply with EN ISO 15118-20:2022, from January 2027 [66] [67]. All V2G supply equipment must be type-tested by an approved third party[20] then obtain a G99 certificate[21] and Distribution Network Operator (DNO) approval before connection [68] [69]. Unlike the Netherlands manufacturers must pay for type-testing. For those wanting to provide 'grid forming' services[22] and participate in short-term stability markets, the GC0137 standard also applies [70]. Whilst G99 shares technical similarities with European requirements it is specific to the UK and any charger sold or installed in the EU must still complete the certification process to obtain a CE mark [71].

6.4 Benefits of publicly funded testing, validation and compliance services

ELAAD's approach of providing free testing, compliance and validation services to OEMs and equipment manufacturers demonstrates the importance of public sector support for V2G innovation. It helps to cut hardware and software development costs, and assure DSOs, OEMs, and charge-point developers that V2G equipment is safe and compliant early in the development cycle. For ELAAD a further benefit is access to the latest V2G hardware, assisting with its development of communication protocols, and compliance evaluation. Additionally, specialist knowledge and expertise that would otherwise reside exclusively within the private sector is held by a public sector organisation with a remit to promote the electrification and system integration of transport.

6.5 V2G car-sharing can achieve both energy system and urban mobility objectives

The electrification of road vehicles is driving the integration of transport and electricity systems. While there are clear health benefits from reduced tail-pipe emissions, and energy system benefits from increasing grid flexibility, policies designed to support EVs often promote private car ownership, rather than

[20] Such as Kiwa, BSI Group and Intertek.

[21] G99 is a mandatory UK regulation governing connection of power generation equipment exceeding 16A per phase (3.68kW single phase) to the electricity distribution network. The standard is designed to ensure grid stability and safety and replaced the previous G59 standard.

[22] Grid forming was formerly known as Virtual Synchronous Machine (VSM) capability. The standard is designed to allow 'converters' (such as renewable electricity generators, storage, and smart load, which includes V2G) to act like traditional synchronous plant to provide grid stability services such as voltage control, inertia and frequency response. GC0137 is not mandatory and only applies to parties providing grid forming.

emphasising reduced car ownership, or public and active travel. Utrecht's approach of providing V2G services via car-share EVs tackles energy system and mobility objectives together with shared benefits that include reductions in grid congestion, parking pressures, private vehicle ownership, and air pollution. In the UK developing programmes to promote V2G in public sector fleets and car-share providers could help better integrate energy and mobility priorities and to spread the benefits of V2G more widely.

6.6 The public sector can play a crucial role in fostering innovation

Utrecht Energized illustrates the critical role the public sector can play in facilitating solutions to grid congestion. In Utrecht, the municipality, DSO (Stedin), ELAAD and ROM have collaborated on five key areas: funding early-stage development and V2G trials; intelligence gathering - mapping and sharing data on grid congestion; regulation - facilitating a flexible approach to demonstrating grid-code compliance; public procurement - inserting V2G capability into EV charger specifications; and partnership building between the public and private sector and universities. This collaboration has provided an environment where the private sector has had the opportunity and incentives to develop V2G as a service.

6.7 Supporting 'disruptors' and enabling experimentation

The development of V2G in Utrecht has been propelled by a small group of 'determined disruptors': dynamic and resourceful individuals in leadership roles in the private and public sectors, who have collaborated around shared objectives and been instrumental in transforming V2G from an idea to an operating service. Such innovators play important roles in challenging cultural and institutional norms, and regulatory boundaries, which can be vital in rapidly changing systems. This extends to the importance of experimenting and 'tinkering' with new technologies to understand their capabilities, limitations, and potential significance [72]. Utrecht's experience highlights the value of maintaining an open mind to disruptors and innovators and of bringing them into the conversation through funding programmes and access to policymakers. It also underlines the importance of flexibility within regulatory regimes, and of intermediaries who can bring actors together.

6.8 V2G business proposition for OEMs remains unclear

Renault's commitment to AC-V2G is significant. It is a departure from the wait-and-see approach adopted by most OEMs to date. Renault is developing and offering V2G as part of a broader package of services including V2G compatible home chargers. It is notable that currently V2G functionality is limited to Renault's own chargers or designated charge points such as those installed by LomboxNet for Utrecht Energized. Whether other OEMs will adopt a similar integrated and proprietary approach to V2G is unclear, and there are uncertainties on V2G flexibility revenues. Revenues may be insufficient to divide between vehicle owners, charge point operators, aggregators and OEMs. In time, owners may come to regard V2G as a standard EV feature which they can take to a range of service providers, in a similar way to network providers for mobile phones. Some OEMs are already exploring energy service offerings to customers, either in partnership with energy retailers, as with BYD and Octopus, or in their own right, and this may allow them to capture revenue from V2G flexibility services. As EV adoption increases, owners may seek to use their vehicle to supply their home or building, rather than offering grid services, particularly if they also have PV. Using EVs to optimise self-consumption rather than grid balancing could impact customer-OEM expectations on who has control over the asset and its use, shaping future business models as well as the wider role of flexibility within energy systems. It also remains to be seen if OEMs can compete with energy retailers and aggregators operating in this space or would be better focused on developing V2G hardware and software capabilities.

7. Conclusions

7.1 Utrecht Energized – demonstrating real-world V2G viability

Utrecht Energized provides real-world evidence that V2G can deliver scalable grid-balancing flexibility using commercially available technology, under operational rather than test conditions. The combination of AC-V2G, car-share fleets, and smart charging software has shown that a single initiative can simultaneously address grid congestion, reduce private vehicle ownership, and accelerate EV adoption. Renault's commitment to AC-V2G and its integration into an affordable vehicle range marks a significant industry development. Equally, the collaboration between We Drive Solar, Stedin, ELAAD, the municipality, universities, MyWheels, Renault and other private actors demonstrates that public-private partnerships supported by strong public sector leadership can accelerate deployment and reduce costs — particularly where DSOs are publicly owned and mandated to support system innovation.

7.2 Unresolved challenges

Utrecht's success rests on a range of specific factors: acute local grid congestion; publicly-funded testing and certification of EV supply equipment and HEMS, and long-term collaboration between public, private and academic sectors supported by a small group of motivated actors able to navigate regulatory and technical challenges. Cities and regions where congestion is less acute, DSOs are privately owned, or institutional relationships are less developed face a materially different starting point.

Beyond context, two structural uncertainties remain. First, there are uncertainties regarding whether the V2G revenue stack — combining flexibility markets, energy arbitrage and avoided network costs — is sufficient to sustain commercial fleet or household V2G propositions without bundling (as Renault, BYD and Octopus have done) or cross-subsidy. There is a discontinuity between flexibility markets and grid infrastructure costs in that revenues and margins from providing flexibility services may not fully reflect the deferred costs or savings from avoiding upgrades to grid infrastructure. If the financial returns from providing V2G flexibility are considered to be too small by vehicle owners and householders they may conclude that vehicle-to-home or vehicle-to-load are better propositions, diminishing the system-wide benefits.

7.3 Priorities for policy and practice

For governments and DSOs, three priorities stand out. First, granular, accessible, geo-spatial mapping of current and forecast grid constraints creates the conditions for lowest-cost solutions, including but not limited to V2G. Second, it is critical to embed V2G capability requirements into public procurement frameworks for EV charging infrastructure before fleet and network decisions lock-in incompatible hardware. Third, harmonised grid codes can help create an environment where OEMs engage early in V2G development. For industry, the clearest signal from Utrecht is that the most viable near-term V2G business models are likely to be bundled rather than standalone: integrating V2G with home energy management, car-share platforms, or energy retail, rather than treating flexibility revenues as sufficient in isolation. For local and regional governments, Utrecht's experience demonstrates the importance of local experiments, private sector partnerships, adopting a flexible approach to regulatory and technical hurdles, and the role of land-use planning and parking policy. By making V2G-compatible charging a condition of planning consent for new residential and commercial development, and by integrating V2G capability into on-street and public car park infrastructure programmes, local authorities can play an important role in developing V2G infrastructure.

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