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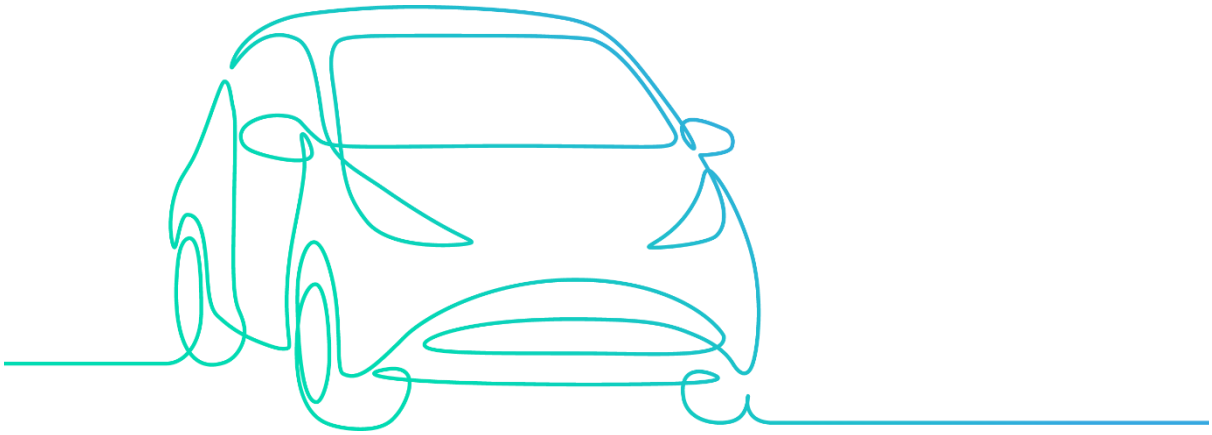

Policy paper with recommendations to facilitate the deployment of V2X

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Statement of Originality

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Executive summary

This document provides policy recommendations on Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B) technologies to public authorities based on the experience of the V2Market project and the barriers encountered. With the rapid electrification of road transport, the smart integration of Electric Vehicles (EVs) into the energy system is essential to avoid grid congestion. Vehicle-to-Grid and Vehicle-to-Building technologies offer the solution for this integration. To facilitate their deployment, public authorities should implement the following recommendations:

- Remove double taxation of the EV battery;
- Implement Electricity Market Design provisions should be consistently across Member States (open access to all markets, aggregator framework etc.);
- Prioritise flexible EVs connection to the grid over other non-flexible electrified assets;
- Support Bidirectional charging capability (V2X, Vehicle-to-Everything)in the European Union (EU) legislative framework, with mandates on long-term duration parking public fleets and in buildings with on-site renewables;
- Incorporate V2X-related data in the EU energy data space, and support interoperability between the vehicles and standards;
- Raise awareness on V2G and V2B technologies to enhance the consumer's acceptance on key concerns such as state of charge, battery degradation or data privacy.

Such recommendations would considerably facilitate the deployment of V2G and V2B technologies and benefit consumers, the energy system and the broader energy transition. Based on the relevance, such recommendations should be implemented at European, national or local level.

Index

List of Acronyms

Acronym	Description
AFIR	Alternative Fuels Infrastructure Regulation
BTM	Behind-The-Meter
CAPEX	Capital Expenditures
CPO	Charge Point Operator
CRM	Capacity Remuneration Mechanism
D	Deliverable
DER	Distributed Energy Resources
DMD	Dedicated Measurement Device
DSO	Distribution System Operator
DSF	Demand-Side Flexibility
EE	Energy Efficiency
EMD	Electricity Market Design
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Contract
ERAA	European Resource Adequacy Assessment
ESCo	Energy Service Company
EU	European Union
EV	Electric Vehicle
GDPR	General Data Protection Regulation
OPEX	Operational Expenditures

PV	Photovoltaic
RED	Renewable Energy Directive
RES	Renewable Energy Source
TOTEX	Total Expenditures
TSO	Transmission System Operator
V2B	Vehicle-to-Building
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
V2X	Vehicle-to-Everything

1. Introduction

Transport accounts for 25% of EU greenhouse gas emissions, with three quarters of this amount coming from road transportation. Transitioning from Internal Combustion Engine Vehicles (ICEVs) to Electric Vehicles (EVs), alongside complementary mobility strategies, is crucial for reducing these emissions and achieving the decarbonisation of road transport. According to the International Energy Agency (IEA), between 48 and 56 million EVs will be on European roads by 2030[1]. If not smartly managed, such vehicles will significantly impact the power system, leading to higher peak electricity demand and additional stress on distribution networks. Conversely, the use of storage capacities in EV batteries offers an opportunity to provide flexibility to the power system, and reduce the risk of constraining grids. Such flexibility can be achieved by optimising the charging process through unidirectional – smart charging – (V1X), or bidirectional charging (V2X). These technologies enable EVs to become an integral part of the power system and be recognised as Distributed Energy Resources (DER). Thus, with the right regulatory framework, V2X could provide 74.3 GW of upward and 41.9 GW of downward available power by 2030, representing a large chunk of the total flexible power available from Demand-Side Resources (DSR) at the EU level[2].

Based on the experience of the European-funded V2Market project, this policy paper draws recommendations addressed at policymakers to incentivise the implementation of V2X services through the EU.

1.1 V2X use cases

V2X builds on V1X – also called smart charging- which enables to dynamically adjust the charging intensity or defer the charging process in response to external signals (e.g. electricity prices, grid conditions, carbon intensity of the electricity mix etc.). It is currently the most frequent form of optimised charging and has already been enshrined in European legislation.[3] Such an optimised way of charging an EV remains unidirectional.

On the other hand, V2X – also called bidirectional charging - gathers several use cases:

- **Vehicle-to-Grid (V2G)** refers to the action of feeding the electricity stored in an EV battery back to the grid, in addition to the features of V1X. The provision of V2G services requires (i) V2G-ready EVs and bidirectional chargers (ii) a regulatory framework allowing this activity and recognising the required stakeholders involved alongside a necessary access to markets.

- **Vehicle-to-Building (V2B)**, in the case of commercial building, or Vehicle-to-Home (V2H) in the case of a residential building, refers to the use of electricity stored in an

[1] https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer
[2] smartEn & DNV, 'Demand-side flexibility in the EU: Quantification of benefits in 2030', 2022.
[3] See the Alternative Fuels Infrastructure Regulation, the Energy Performance of Buildings Directive, the Renewable Energy Directive.

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EV battery to power buildings. Combined with self-production of renewable energy e.g., with solar photovoltaic (PV) panels, this maximises the benefits for consumers while ensuring a synergy between renewables and the EV.

- Finally, **Vehicle-to-Load (V2L)** uses energy to power an appliance or another EV.

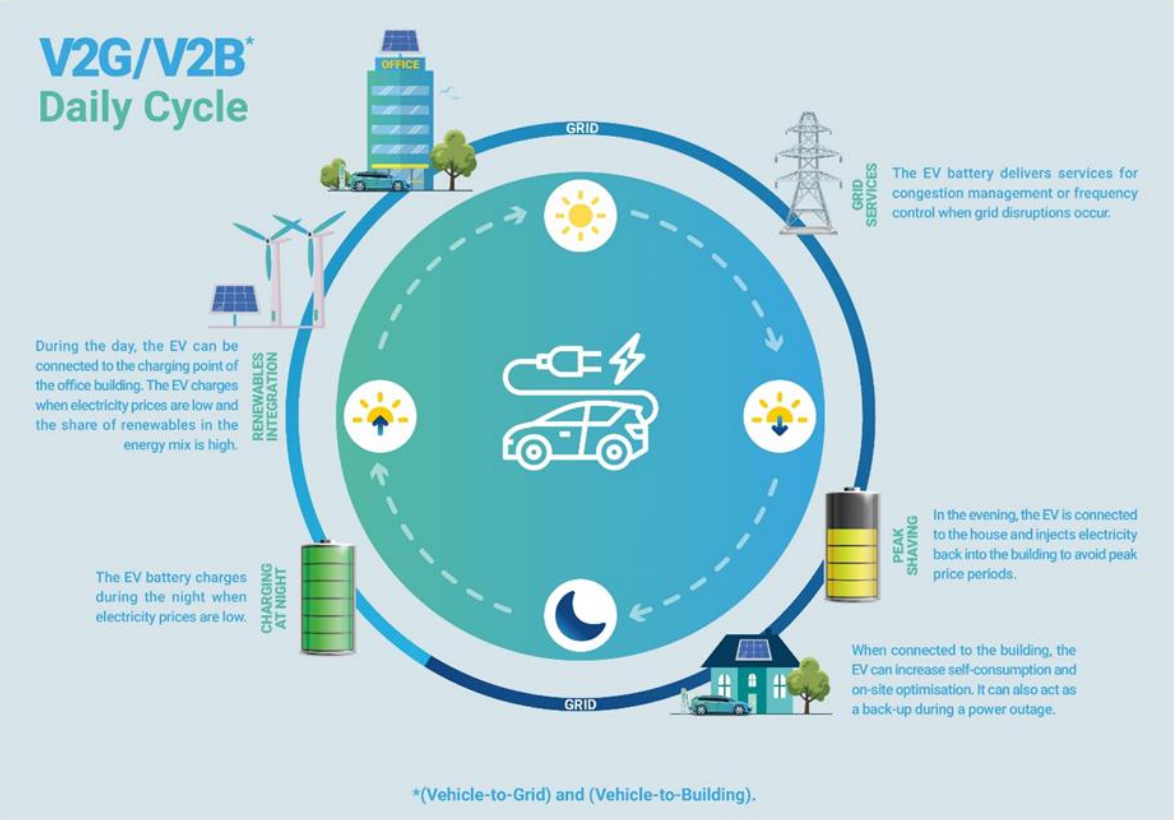

Figure 1 - V2G/V2B Daily Cycle[4] - V2Market Project

[4] This graphic illustrates how an EV battery can be optimized through V2G and V2B services, combined with the self-consumption of renewable electricity.

1.2 Background: Presentation of V2Market pilots

This policy paper builds on two pilots developed in the context of the V2Market project.

The initial pilot took place in the Metropolitan Area of Barcelona (AMB), where the municipality installed bidirectional chargers in its parking. The primary goal of the pilot was to provide Vehicle-to-Grid (V2G) services by accessing wholesale markets. However, regulatory barriers in Spain led to a revision of the pilot's ambitions. Currently, the pilot simulates V2G use of car batteries using a platform developed by OMIE, the Spanish electricity market operator. The pilot run different market scenarios based on the actual evolution of the Spanish Intraday market. Nuvve, an independent aggregator specialized in V2G services, considers these scenarios to create a virtual optimization of available resources and bidding on the OMIE simulation platform. The market outcome is then used to dispatch orders to the electric vehicles (EVs). It is important to note that the electricity is not fed into the grid but remains within the Barcelona municipality's premises (because of the current regulatory limitation). The pilot aimed to investigate potential revenues from accessing the Spanish Intraday market for V2G technologies.

Figure 2 - AMB Pilot Site

The second pilot is focused on residential customers. It is exploring the behaviour, patterns and interactions of users with photovoltaic (PV) and EV in terms of smart charging, and the core principles of demand response and its interaction with the energy markets. Holaluz, a renewable electricity supplier, along with Nuvve acting as an energy management service provider, is proposing a smart charging service to its residential customers. This service involves providing personalized advice to each residential user, including recommendations on the best charging times to help save on energy costs.

Figure 3 - Holaluz Pilot Site

2. Regulatory barriers and recommendations for the development of V2X services

2.1 Ensure appropriate taxation of stored energy in EV

One of the primary obstacles preventing bidirectional charging business models to strive is double taxation, where energy from an EV battery is taxed both when charged and when discharged to the grid. Energy storage assets such as EV batteries, can be considered as both a producer and consumer of energy. Hence, for taxation purposes, the energy consumed from the grid may be taxed. If considered as a producer, once the energy is injected again to the grid and consumed by another final end user, it will be taxed another time. This burden significantly reduces the revenue potential for flexibility service utilising V2X.

The ongoing revision of the Directive 2021/0213 (Energy Taxation Directive) at the EU level provides an excellent opportunity to eliminate this barrier. However, due to the sensitive nature of taxation issues at the European level, progress on this file is stalled, making it unlikely to be adopted in the short-term. In the meantime, national policymakers should act to remove double taxation within their respective countries. This would already remove barriers and facilitate the growth of V2X in many European markets. Several European countries, such as Italy, Spain or Sweden have already abolished double taxation. Conversely, this issue persists in countries like Belgium, Denmark and Poland. In Germany, a specific discrimination exists for V2G, as double taxation has been removed for stationary storage assets but not for mobile ones.[5]

2.2 Implement the Electricity Market Design framework

The EU Electricity Market Directive (2019/944) and Regulation (2019/943) provide various provisions to encourage flexibility, including from EVs, to participate in energy markets and enable flexibility-related business models. These two files have been adopted in 2019. In response to the energy crisis in 2022, an amendment has been made which resulted in new measures further supporting flexibility[6].

However, the framework from 2019, supposed to be implemented by Member States by 2020, was in a poorly manner, significantly hampering the uptake of demand-side flexibility (DSF) services like V2X. National policymakers together with National Regulatory Authorities (NRAs) should implement EU law without any delay, as this would remove considerable barriers to the uptake of V2X – and DSF overall.

Key rules to be implemented include:

[5] smartEn & DNV, “V2X Enablers and Barriers: Assessment of the regulatory framework of bidirectional EV charging in Europe”, 2023.
[6] See Directive 2024/1711 and Regulation 2024/1747

- **The consistent rollout of smart meters, as per article 19 of the Electricity Directive**.[7] As of now, smart meter deployment is very uneven across Europe, with countries close to 100% while others barely started. Smart meters are crucial to allow real-time communication and measurement of energy patterns, hence relevant for V2X. Regardless of this rollout, the use of dedicated measurement devices (DMDs) and sub-meters remains an essential tool, as per article 7b of Regulation 2024/1747 (Electricity Regulation), to support flexibility activation. These devices can offer consumers accurate data on their electricity-consumption patterns. They also empower consumers by enabling them to utilise the flexibility of specific assets such as EVs or heat pumps without having to activate other assets, which could be inconvenient for the consumer. They will allow the provision of services also in absence of a smart meter.

- **The access to all electricity markets, as outlined in article 17 of the Electricity Directive through an aggregation framework.** This barrier was particularly prevalent in the context of this project, as there is no clear independent aggregation framework existing in Spain. Therefore, this was impossible for independent aggregators to access markets and sell the EVs flexibility. Enabling value stacking by providing access to all markets, including local flexibility markets, would also allow for earning revenues by providing multiple services. In particular, balancing markets particularly fit the technical capacity of EV batteries.
  Value stacking would further optimise flexibility procurement and use, as one asset can be used where it is most needed.

- **The inclusion of V2X in Capacity Remuneration Mechanisms (CRMs).** Typically, these mechanisms are set after an adequacy assessment highlighting future long-term supply shortages. To avoid security of supply risks, Capacity Mechanisms compensate assets, traditionally power plants, to keep capacity available , in addition to the income derived from their regular electricity sales operations. Article 19g of the 2024 Electricity Regulation introduces flexibility support schemes as a complement to CRMs, “consisting of payments for the capacity of payments for the available capacity of non-fossil flexibility”. Member States which apply CRMs should also consider adapting their design to facilitate the participation of demand response and storage. Therefore, V2X should be fully considered under these schemes as a critical storage solution.

- **Incentives to DSOs procurement of flexibility.** As EVs are connected to the distribution grids, they need to be smartly integrated, to avoid further strains on distribution networks. Hence, it is important for DSOs to be able to procure flexibility. Article 32 of the Electricity Directive promotes this procurement. However, barriers remain. For example, the remuneration scheme for DSOs is mainly based on capital expenditures (CAPEX), rather than on total expenditures (TOTEX), which includes

[7] Article 19 of the Electricity Directive conditioned the rollout of smart meters to a cost-benefit analysis (CBA). As of 2023, 21 Member States had a positive CBA, 2 did not completed one, while 4 had an inconclusive one. Such a CBA should be reassessed swiftly. For more information please see: “Clean Energy Technology Observatory: Smart Grids in the European Union - 2023 Status Report on Technology Development, Trends, Value Chains and Markets”, Joint Research Centre, 2023.

operational ones (OPEX). CAPEX traditionally covers grid capacity reinforcement, while flexibility procurement and activation are an OPEX. Hence, the price control scheme should be based on TOTEX, and incorporate incentives for digitalisation, grid optimization, and advanced communication tools.[8] Additionally, DSOs should consider new emerging products, like peak shaving products. As highlighted by smartEn & DNV, the procurement of flexibility can lead to a reduction in the needed investment in distribution networks of between 11.1 and 29.1 billion euros at the European level in 2030.[9]

Other rules from the Electricity Market Design which have not been consistently implemented remain a major blocker for V2X, such as high minimum bid sizes (often higher than the 500kW maximum set for day ahead and intraday markets, which has been lowered to 100kW in the revision of the Electricity Regulation in 2024)[10], procurement of flexibility from TSOs[11], access to dynamic tariffs, double network charges, difficulty from aggregators to pool different types of assets, or lengthy prequalification processes.

2.3 Prioritise flexible EVs for grid connection

Congestion in distribution grids is increasingly occurring across Europe. This issue will likely worsen as the necessary adoption of electrified assets at the distribution level grows to meet EU climate objectives. This results in lengthy grid connection processes, sometimes the inability to connect electrified assets to the grid. For example, in Poland, 60 to 80% of consumers are denied a connection.[12] This issue also affects EVs, where countries with relatively high shares of EVs consider denying their chargers' connection to the grid.[13] This is concerning. Consumers would only be incentivised to purchase EVs if they have the guarantee to have a grid connection, ultimately jeopardising the road transport decarbonisation.
To reverse this trend and alleviate grid constraints issues, DSOs should:

- **Prioritise the connection of flexible-ready EVs[14], through smart and bidirectional charging:** This approach would significantly reduce grid capacity needs and facilitate the connection of EVs. It requires proper mapping of both the flexibility potential and the availability of EVs at the distribution level.

[8] For example, countries like the UK or Portugal already use a TOTEX approach to price-control for the electricity grid.
[9] smartEn & DNV, 'Demand-side flexibility in the EU: Quantification of benefits in 2030', 2022.
[10] See article 8 from the Electricity Regulation
[11] As DSOs, TSOs should also properly assess the potential of V2X, and include the technology in their European Resource Adequacy Assessment (ERAA). For more information, please see https://smarten.eu/wp-content/uploads/2024/03/smartEn-letter-ERAA-2023_final.pdf
[12] Polska Grupa Energetyczna (PGE), Polish Association of Professional Heat and Power Plants, 29 June 2023.
[13] For example, in the Netherlands, the grid operator wanted to forbid public charging during evening peak times to avoid outages. https://nltimes.nl/2024/02/27/grid-manager-wants-turn-electric-car-charges-1600-2100
[14] This prioritisation does not impact the connection of households to the grid, as system operators have the obligation to connected them by law. It only concerns the connection priority of flexible EVs over non-flexible EVs.

- **Procure flexibility through the setup of local flexibility markets**: As mentioned in the previous section, establishing these markets would be the most efficient and cost-effective solution to ensure a stable network, all while delivering value to all stakeholders in a market-based manner, aligned with EU legislation

Some positive elements have already been put forward in EU legislation. The 2024 Electricity Market Design incentivises DSOs to facilitate the connection of smart and bidirectional charging points. Additionally, the EMD mandates an EU-level assessment of flexibility needs. Given that most EVs are connected to the distribution grid, it is crucial for DSOs and, to some extent, local public authorities to address the grid connection issue by further promoting and empowering V2X business models.

2.4 Incentivise bidirectional charging capability in the EU legislative framework

The European legislative framework includes references to bidirectional charging:

- The Alternative Fuels Infrastructure Regulation (AFIR) foresees an assessment of all charging points on the contribution of EVs to the flexibility of the system, including V2X, is foreseen.
- The Energy Performance of Buildings Directive (EPBD) mandates bidirectional charging capability 'if appropriate' on certain types of buildings.
- The Renewable Energy Directive (RED) mandates, bidirectional charging capability 'if appropriate' for non-publicly accessible charging.

The implementation of these references at the national level remains unclear despite being steps in the right direction. To have the maximum impact, bidirectional charging should be strategically mandated in locations offering the greatest benefits, such as:

- **Buildings with on-site renewables, for example those with solar panels on rooftops.** V2H/B can maximise the financial benefits for the consumer by considerably lowering energy bills, and ensuring that the EV is charged with clean energy.

- **Public buildings with public fleets with long-duration parking.** Implementing bidirectional charging in such locations can set a precedent for broader adoption. Public authorities, as early adopters, can drive the technology's expansion, promoting energy-efficient practices and reducing energy costs, which ultimately benefits taxpayers. To that end, local administrations should develop comprehensive plan for installing bidirectional chargers in public spaces.

Other use cases that could be considered include long-duration parking such as overnight vehicle parks (airports, hotels etc.), and office-building parking spaces.

2.5 Ensure data sharing from all relevant stakeholders

It is essential for flexibility service providers to have access to data in order to leverage the potential of EVs. However, accessing this data can be challenging due to reluctance or practical difficulties from stakeholders (Charge Point Operators - CPO - , vehicle manufacturers etc.) in sharing it. Indeed, the V2X data ecosystem involves data from a wide range of stakeholders in the energy and transport sectors, including the vehicle, charge point, consumer, System Operator etc.

4 main data flows can be identified:

- between behind-the-meter (BTM) assets – including V2X
- between BTM assets and the flexibility service provider
- between BTM assets and System Operators
- between flexibility service providers and System Operators.[15]

Each of these data flows use different standards and ontologies. It is essential to create a unified EU Energy Data Space that incorporates V2G-related data and provides a single access point for flexibility service providers to access energy and mobility data.

The EU has established data-sharing rules in the Data Act (Regulation 2023/2854), which forces all manufacturers to provide all product data to customers and if they allow to third parties. The Renewable Energy Directive (2023/2413) supplements this Regulation, requiring vehicle manufacturers to make available data in real-time on the battery state of health, battery state of charge, battery power set point, battery capacity, and, where appropriate, the location of electric vehicles. Additionally, the Alternative Fuels Infrastructure Regulation requires CPOs to share a set of static and dynamic data. These data are crucial for the uptake of V2X, as it gives third parties the tools to shape robust business models. It is key that these data remain harmonised, standardised and interoperable at EU level preventing discrepancies between countries and enabling flexibility service providers to operate across different markets effectively.

In addition, the majority of EV manufacturers have already proposed or announced the launch of V2X-ready EVs in European markets. Therefore, it is essential to build consumer trust by ensuring that the sales of bidirectional chargers follow this trend and are interoperable, allowing consumers to bidirectionally charge their vehicles wherever they want.

[15] For more information, please check at the following paper: https://smarten.eu/wp-content/uploads/2023/06/smartEn-Standards-mapping-position-paper_final.pdf

3. Social barriers and recommendations for the development of V2X services

One critical factor for the successful deployment of V2X technology is gaining end-user acceptance. Since V2X is a new concept for consumers, it's essential to actively involve them in the process by addressing their concerns with effective solutions. The following section aims to tackle some of these key issues.

3.1 Tackle battery-related anxiety

Guarantee an appropriate state of charge and empowerment of consumers

One major concern among EV drivers is that V2X services might deplete their vehicle's batteries, leaving them without sufficient power when needed. However, a user-friendly interface between drivers and service providers can address this issue. When an EV is connected to a charging station (whether unidirectional or bidirectional), the owner can specify their desired and minimum charge levels[16], as well as the charging window duration. An advanced algorithm then optimizes the charging schedule based on these parameters, aiming to minimize costs and carbon emissions for smart charging, or maximize revenues through market participation and building energy management for bidirectional charging. [17]

However, this alone might not be enough to reassure consumers to engage in V2X services. In a survey conducted in the Netherlands on smart charging, 73% of respondents stated that they want the ability to access the charging session, and 76% access to transparent information.[18] Hence, consumers should be able to override automated charging decisions easily. An “opt out clause” could address this concern. Although rarely used, it provides reassurance and builds acceptance of V2X services, as shown by some pilots.[19]

Tackle the battery degradation concern

Battery degradation i.e., the depletion of the battery capacity due to V2G/B activities, is a concern for many consumers. The scientific literature has diverging views on the matter, but it isn't clearly demonstrated that V2X significantly impacts capacity. In fact, optimizing battery usage through third-party control is often more beneficial than uncontrolled charging, highlighting the advantages of V2X.[20]

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[16] For example, the company Octopus proposes to set a minimum state of charge when signing up the contract. https://octopus.energy/power-pack/
[17] For other examples, please check FLEXO smart charge developed by Hive Power. https://www.hivepower.tech/flexo/smart-charging
[18] Rijksdienst voor Ondernemend Nederland, “Nationaal laadonderzoek 2022: Laden van elektrische auto’s in Nederland: Ervaringen en meningen van EV-rijders”, 2022.
[19] SCALE Project, “Stakeholder Analysis – Project Deliverable D1.2”, 2022.
[20] Kotub Uddin *et al.*, “On the possibility of extending the lifetime of lithium-ion batteries through optimal V2G facilitated by an integrated vehicle and smart-grid system,” Energy, 2017.

To address battery degradation concerns, several solutions should be implemented:

- **Include V2X in battery warranties:** car manufacturers should explicitly mention V2X in vehicle warranties, to increase consumer confidence. Car manufacturers should also consider expanding the number of charging cycles covered.

- **Cover degradation with service profits:** If V2X causes any additional degradation, the delivery of V2X services must be financially beneficial for the end-user, balancing out the incurring costs related to battery degradation.

- **Adopt a servitisation business model:** This model, as demonstrated in the V2Market project, involves end-user owning the car, and an aggregator owning the battery. This model could reassure and engage more consumers as the aggregator would guarantee the replacement of the battery. This would facilitate their acceptance and commitment to the technology. More information on the servitisation model can be found on the V2Market website[21].

Figure 4. Servitization Model Overview. Source: V2Market project

Finally, consumers should bear in mind that an EV battery, once its capacity is too low for transportation, can still be repurposed to serve as a stationary battery. This is particularly for households with solar panels, as it provides an complementary energy storage solution.

[21] V2Market. D4.2 Hybrid EPC Servitisation Contracts. 2022.

3.2 Protect consumers' data

Many consumers are worried about their data privacy regarding flexible energy solutions, and V2G/B is no exception, as it involves third parties accessing data indicating user behaviour to optimise the service delivery.

To address these concerns, service providers should follow these principles:

- **Consumer consent**: Consumers must provide explicit consent for any service accessing their data, and the service provider must be upfront and transparent about what data will be used and for what purpose.

- **Apply existing legal protections:** Existing EU legislation, including the GDPR, already protects consumer data privacy and ownership, balancing consumer protection with the delivery of innovative third-party services. The EU has adopted a network code of cybersecurity with a special focus on the electricity sector, including flexibility service providers.

In addition, ongoing EU initiatives are expected to bring additional legal clarity on this matter. The European Commission is currently preparing an implementing act on interoperability of data for demand response. This act will regulate aspects such as data sharing and portability, and should be centred on consumer's protection and consent. This transparency will build consumer trust in V2X technologies.

4. Conclusion

V2G and V2B are proven technologies poised to play a prominent role in the energy system. To fully achieve their potential, policymakers at the EU, national and local levels need to provide incentives for these technologies and establish a supportive framework. This paper outlines key recommendations to remove regulatory and social barriers hindering the widespread adoption of V2G and V2B.

These recommendations are in line with the findings of the V2Market Project, which faced challenges in deploying V2G chargers despite strong interest from all stakeholders, including local authorities. Some of these challenges were directly related to the barriers outlined in this paper. Effective coordination and strategic planning among all parties are essential for overcoming these obstacles and ensuring successful implementation.

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