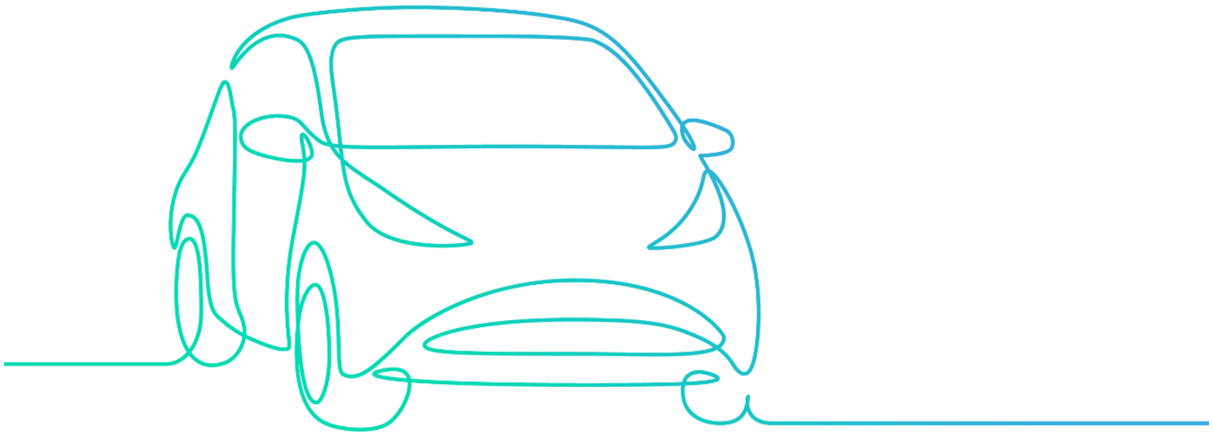

D2.1 Design Thinking Structure

D2.1

May 2022

Deliverable

PROJECT ACRONYM	GRANT AGREEMENT #	PROJECT TITLE
V2Market	101033686	V2Market

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D2.1

Design thinking structure and materials rationale of the chosen scope, methodology and outputs

Revision: <v1.1>

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✓ **P** **Public**

C Confidential, only for members of the consortium and the Commission Services

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Statement of Originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Executive Summary

The European Union has embarked in a transition to a sustainable, carbon-neutral mobility sector. To do so, the EU promotes and envisages an energy system dominated by highly distributed renewable energy sources. In this context, an increasingly flexible and efficient energy system shall have to be set in place. Residential consumers, facility managers, as well as EV owners and fleet operators will gradually take a central role in the well-functioning of the energy system. That is, consumers shall transition from acting as passive recipients to prosumption: that is, to manage their consumption according to grid necessities, and to synchronise it with periods in which energy may be cheaper, and the power mix may exhibit a larger share of renewables.

The V2Market programme is financed by the European Commission, under the H2020 programme, which aims to develop, test, and adapt to end-user needs the next generation of smart energy services valorising energy efficiency and flexibility at the demand side. The programme sets in focus on electric vehicles and explores the possible pathways to incorporate them into the energy system as storage and flexibility capacity through Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B) technology.

The programme thus intends to develop business model propositions capable of creating value for all the actors involved in the provision of flexibility services through V2B/V2G. This deliverable constitutes the first phase of a comprehensive market study to identify and evaluate the possibilities to commercialise V2B/V2G services, also referred to as V2M or V2Market services, in a manner that is accessible, affordable and beneficial to all relevant stakeholders: EV users, fleet operators, aggregators, energy utilities, facility managers, among others.

Therefore, this deliverable comprises two comprehensive marketing tools applied to the analysis of V2B/V2G services, which provide a preliminary assessment of the commercial potential of these services, as based on an interdisciplinary literature review and on the wide knowledge pool brought together by the partners of the consortium. The first of the two analytical tools -a SWOT – offers a comprehensive description of the strengths, weaknesses and future and external opportunities and threats the commercialisation of V2B/V2g may face. Finally, the second tool – Customer Journey Canvases – represents a thorough examination of the customer experience of V2B/V2G of the most likely end-users of the services. The findings of this deliverable have guided the objectives and research questions explored in D2.2, in which the market study is furthered through interviews and focus groups conducted with diverse market actors involved in sustainable mobility.

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List of Acronyms

Acronym	Description
AC	Alternate Current
BRP	Balance Responsible Party
DC	Direct Current
DER	Distributed Energy Resources
DoD	Depth of Discharge
DSO	Distribution System Operator
ESCO	Energy Service Company
EU	European Union
EV	Electric Vehicle
ICEV	Internal Combustion Engine Vehicle
RES	Renewable Energy Sources
SoC	State of Charge
ToU	Time of Use
V2B	Vehicle-to-Building
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
V2M	Vehicle-to-Market
V2Market	Vehicle-to-Marke
WP	Work Package

1/ Background and Objectives

This deliverable presents the first market assessment conducted to identify and estimate the strengths, barriers, and limitations that the commercialisation in European markets of Vehicle-to-Building (V2B) and Vehicle-to-Grid (V2G) services may face. It provides a comprehensive evaluation of the legal, technical, and financial feasibility of launching V2B and V2G to the mass market, as well as the conditions for social acceptance they are likely to encounter.

The present deliverable aims to develop a generic preliminary study of the current market conditions for V2G/V2B, on which the remainder of Work Package 2 will draw to elaborate an exhaustive market study. To this purpose, this deliverable constitutes a multidisciplinary literature review of existent research and knowledge of relevance for the Work Package, as well as a compilation of the practical expert knowledge of the consortium.

Specifically, this deliverable elaborates and applies the process of reviewing literature to the composition of two well-known marketing tools used globally by businesses to thoroughly evaluate whether, how and when to launch a product or service: a SWOT study and a Customer Journey Canvas. Both marketing tools have been adapted in this deliverable to meticulously document the user experience in terms of access barriers, needs and interests.

The results of both tools, which summarise the literature review and consortium expertise, will be used to structure and guide the continuation of the market study through the expert interviews and focus groups developed as part of D2.2.

The deliverable is structured as follows. First, it details the methodology used to elaborate both the SWOT analysis and the Customer Journey Canvas. Second, the deliverable summarises the content and uses of a SWOT analysis and proceeds by detailing the SWOT results as concerns the commercialisation of V2B/V2G. Third, it introduces the final customer typologies of V2B/V2G services defined by the consortium. Fourth, it describes the Customer Journey Canvas format proposed by the consortium, as well as each final customer typology. The deliverable concludes with the five developed Customer Journey Canvases.

1/ Methodology

The analytical tools that make up this deliverable followed a design thinking methodology. Design thinking consists of an iterative non-linear collective process that seeks to understand the user perspective and experience of a particular product or service (Sandino et al., 2013). As such, design thinking entails the identification and questioning of pre-established assumptions regarding customer purchasing power, interests and behaviour patterns; the definition of product-specific customer typologies; and the assessment of the extent to which the product of interest fulfils users' needs and desires.

To do so, the deliverable develops end-user typologies for V2B/V2G services and provides the following two prominent marketing tools.

- A SWOT analysis: A systematic evaluation of the internal strengths and weaknesses that the integration of V2B and V2G services have, disaggregating these into those affecting end-users, and potential aggregators. The SWOT also addresses the external contextual features of market competition, production and commercialisation costs, technical requirements, social acceptance and regulation that will condition the market entry of V2B/V2G.
- A Customer Journey Canvas and Experience Profiles: This canvas and the consequent experience profiles describe with richness of detail what the customer experience will be like with V2B/V2G throughout the lifecycle of the services. This extends from the first information gathered on V2B/V2G, to their choice to retain the services. The Customer Journey Canvas, in line with the design thinking methodology, imply a team exercise of empathy and acquaintance with each user typology's interests, values, modus operandi and external constrains.

For both tools, the deliverable builds on an exhaustive literature review addressing the implementation of V2G and V2B technology. The research and composition of the literature review was executed by a multidisciplinary team which reviewed existent academic studies and grey literature in electric and industrial engineering, business economics, and social sciences. Moreover, both tools were composed based on the insights collected in multiple bilateral meetings between consortium partners in which sessions of brainstorming, critical analysis and collaborative work took place.

The elaboration of both the SWOT analysis and the Customer Journey Canvas worked as an evolving knowledge basis, which greatly helped and oriented the ideation of the content of the expert interviews and the focus groups conducted as part of D2.2 and D2.3 of the same Work Package.

Electric vehicles chargers

For clarity, this subsection specifies the two definitions used in this deliverable when addressing EV chargers.

Slow/Normal or **Home-chargers**:

- Power level 2 (higher than 3.7kW up to 22kW). Usually using the onboard battery charger of the vehicle, they supply single or 3-phase AC outlet. Some of these chargers can sustain bidirectional power flows if the on-board charger is capable of bidirectional power conversion. Others include an offboard battery charger (i.e., power electronics in two stage AC/DC and DC/DC converter). Similarly, some of those using the CHAdeMO standard also allow bidirectional power flows. To the purpose of illustration, a product currently available in the market which suits these requirements is Quasar from Wallbox.

Fast or high-power chargers:

- Power level 3 (higher than 22kW) – with offboard battery charger that converts 3-phase AC power to a DC supply (two stage AC/DC and DC/DC converter).

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2/ SWOT Analysis

A SWOT is an analytical tool that evaluates the strategic position that a given service or commodity has in relation to substitutes or alternatives that are commercialised in the market (Helms & Nixon, 2010). The study presented below firstly expounds the inherent strengths and weaknesses of the integration of vehicle-to-grid and vehicle-to-building services, from both the perspective of EV owners and that of potential aggregators.

That is, the integration of V2B and V2G services is assessed as a business opportunity for aggregators, and as a final service offered to EV owners. In this manner, the SWOT provides a comprehensive examination of the various ways in which V2B/V2G services contribute to, or undermine, EV owners and aggregators' interests.

Secondly, the SWOT study provides an analysis of the various contextual factors - external to the proposal of integrating V2B and V2G technology - that can make it succeed as a business case. It thus offers a holistic overview of the social, political, economic, legal, technological, and ecological elements that may emerge as relevant opportunities and threats for the broad market commercialisation of the V2M (i.e., the integration of V2B and V2G services).

This section is structured as follows. The SWOT study initially addresses the strengths and weaknesses of the V2M, dividing these into those concerning EV Owners on one side, and aggregators and DSOs on the other side. Subsequently, it details the opportunities and threats for the V2M launch into the European market. The section concludes with an infographic that summarises the main findings of the SWOT study.

2.1 SWOT: Main factors

2.1.1 Strengths for EV Owners and V2M customers

1) Prosumer savings on energy expenditure

V2M services allow the EV user to make use of its vehicle to become more energy-efficient, hence having the potential to reduce overall energy expenditure in multiple ways.

Firstly, V2G allows the EV user to discharge energy stored in the battery onto the grid. A widely studied strategy is load shifting (Pang et al., 2012) which makes use of electricity price fluctuations during grid congestions or peak load to significantly decrease electricity bills (Raghavan & Khaligh, 2012). Secondly, V2B services allow the EV user to discharge the stored energy, but in this case onto a building. Also, through load-shifting, the energy bill can be reduced. Moreover, V2B can be utilised to optimize renewable energy production in-situ, in case distributed energy resources (i.e., DER) are present (e.g., residential, or commercial PV installations). In this case, the car could function as a local battery storage.

While adjusting one's own mobility habits to the demands of the grid may be experienced as a limitation by users, Saele & Petersen (2018) illuminate that, on average, demand-side management proved socially acceptable among Norwegian EV users: 90% of respondents in their study said that delayed charging had no negative effect, 40% of respondents were eager to change significantly their driving habits if yearly savings topped 200€, and 26% if the savings were just 50€.

2) Status-enhancing public image

Numerous studies indicate that the use and ownership of EVs and of innovative energy-efficient technologies such as V2G and V2B, are on average not considered to be status-degrading across public opinion (e.g., Figenbaum et al., 2015). Otherwise, being an innovator or an early adopter in this field is widely associated with positive social recognition, and with the development or consolidation of opinion leadership in the innovator's community (Rogers, 2002). This factor boosts existing and potential EV users' willingness to engage with these technologies, to change their mobility patterns (Bienias et al., 2020), and to convince further people to contract V2B and V2G services.

3) Air Quality and Sustainability

Human mobility is a global driver of air pollution and greenhouse gas emissions. Nonetheless, the greenhouse gas emissions produced by internal combustion engine vehicles (i.e., ICEVs) and EVs differ widely.

In contrast with ICEVs, EVs produce virtually no tailpipe emissions, hence contributing to both human health and the mitigation of climate change (Abdul-Manan, 2015). It is worth noting however that as occurs with most wheeled vehicles, the breaking and degradation of tires produces emissions.

While the differential air quality benefits of EVs will also be shaped by the share of renewables that are present in the power mix, as well as on the type of energy and technologies deployed for the processes of mineral extraction, vehicle manufacturing, and electronic recycling; overall EVs have the potential to decrease the emissions produced by the mobility sector, contributing to the transition towards a cleaner and a more resilient energy system.

4) Empowerment of the user in contractual agreements with energy retailers

The European Union is on the transition towards an energy system with an increasing contribution of renewable sources. Therefore, the role of flexibility instruments, such as demand response and energy storage will be crucial to ensuring its accomplishment. The on-going development of local flexibility markets envisages a proactive participation of consumers and the prospect to take advantage of smart energy infrastructures (Bellekom et al., 2016).

Moreover, Spanish consumers are currently encouraged to adjust their consumption profiles according to a three-tiered electricity tariff to reduce energy consumption at peak hours. This framework could further promote the use of behind-the-meter batteries associated to PV systems and V2M schemes (LSE, 2020).

To benefit from this new scenario and to reap the benefits that dynamic tariffs can yield to end-users, prosumers will have to switch from a mere consumption role to a proactive management of their energy use. V2Market facilitates a means for end-users to do so: enabling them to offer flexibility services to the grid.

More specifically, V2B/V2G empowers end-users in prosumption, as it enables them to respond to signals (e.g., price) by shifting the charging of the EV to when prices are expected to be low and injecting power into the grid or a building when prices are high. This is a strength of V2M compared to other energy assets of the prosumers which are much less flexible, if at all (e.g., solar panels and local batteries).

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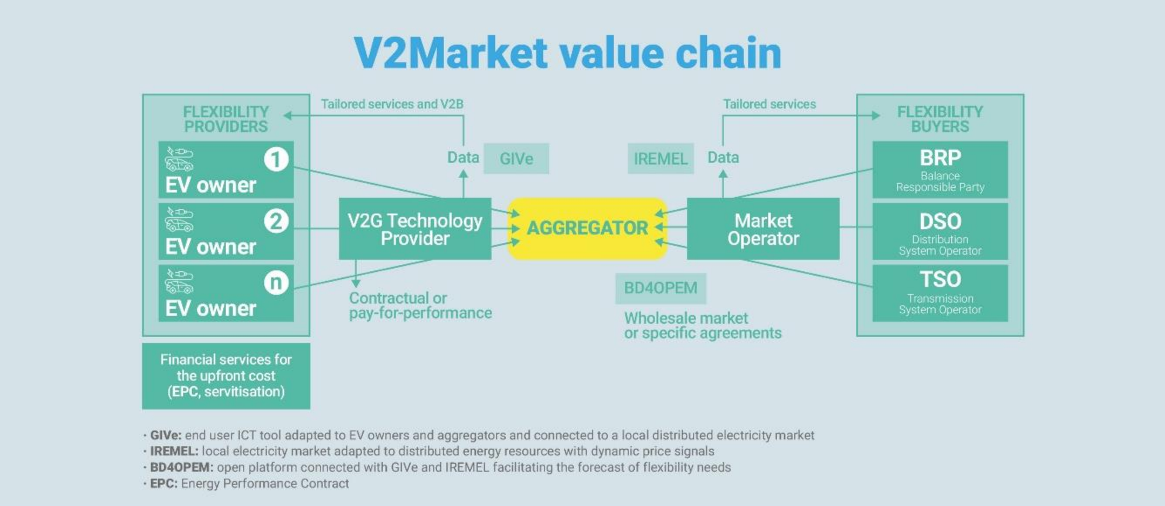

Figure 1: V2Market Stakeholder Map

5) Additional revenue for users through participation in different markets

A strength of V2M is that it turns vehicles into productive use assets even when they are idle (i.e., parked). V2M expands and reinvents the value of the vehicle, by yielding value not only for its owner, but also for the system; and not only when it is used to drive around, but also when it is motionless. EV owners and V2M customers will be able to tap into an additional source of revenue through contracting V2B/V2G services by participating in different markets, such as (a) single day ahead market, (b) intraday market sessions, (c) local flexibility markets and (d) ancillary services (e.g., frequency and voltage regulation, different types of reserves).

It is worth noting that V2M customers capable of providing few flexibility resources (i.e., small fleets or individual EV owners), will only be able to participate in these markets by selling flexibility to aggregators: on their own, they may not be able to fulfil the minimum access requirements that qualify flexibility sellers to access these markets. In this case, aggregators will be responsible for managing the participation in the markets described above. These markets are all crucial to preserve power quality and to ensure the balance of the electric system.

As such, through V2B/V2G, users shall sell their flexibility to aggregators, who will in turn:

- Locally supply active and reactive power when needed thanks to the power converters of their architectures.
- Absorb spikes of active and reactive power locally generated by DERs soaking excess energy into their battery and regulating electricity with their power converter.

These characteristics make EV owners potential participants of the above-mentioned markets. Nevertheless, aggregation of several bidirectional chargers is going to be necessary in order to participate in markets, which currently require minimum bid sizes that are hard to reach (e.g., in the UK, 1 MW response power is required for primary reserve). Altogether, remunerated provision in these markets through V2G schemes would not only contribute to stabilise the grid and ensure its capacity to meet electricity demand, but also constitute an additional source of revenue for V2M participants (Sortomme & El-Sharkawi, 2011; Liu et al., 2013).

2.1.2 Strengths for Aggregators, ESCOs and DSOs

1) New market for aggregators

To date, in Spain, as well as in various other countries, there are no established and legally actionable local flexibility markets. In these markets, flexible DERs shall assist the grid in solving congestions that at times emerge at the level of distribution (Minniti et al., 2018). To do so, the market price for energy may be adjusted for congestion management. Subsequently, DERs capable of regulating their energy usage shall adapt their production and/or consumption in accordance with these prices' signals, obtaining higher profits by providing services to the grid.

The inclusion of EVs engaging in V2B/V2G into these markets, or the participation in brand-new local flexibility markets when these shall be created is a relevant strength of the V2B/V2G business case. Through V2B/V2G, aggregators will be able to commercialise two types of services.

- Local flexibility provision to solve sporadic zonal problems requiring the modification of the consumption/production of one or multiple DERs located near these areas.
- Middle/long term Services DSOs shall contract to ensure the availability of DERS on specific zones prone to having problems. A contract could be established in which DERs agree to modify their consumption and/or production should it be needed, and as an alternative to both grid expansion and to other means of power outage prevention.

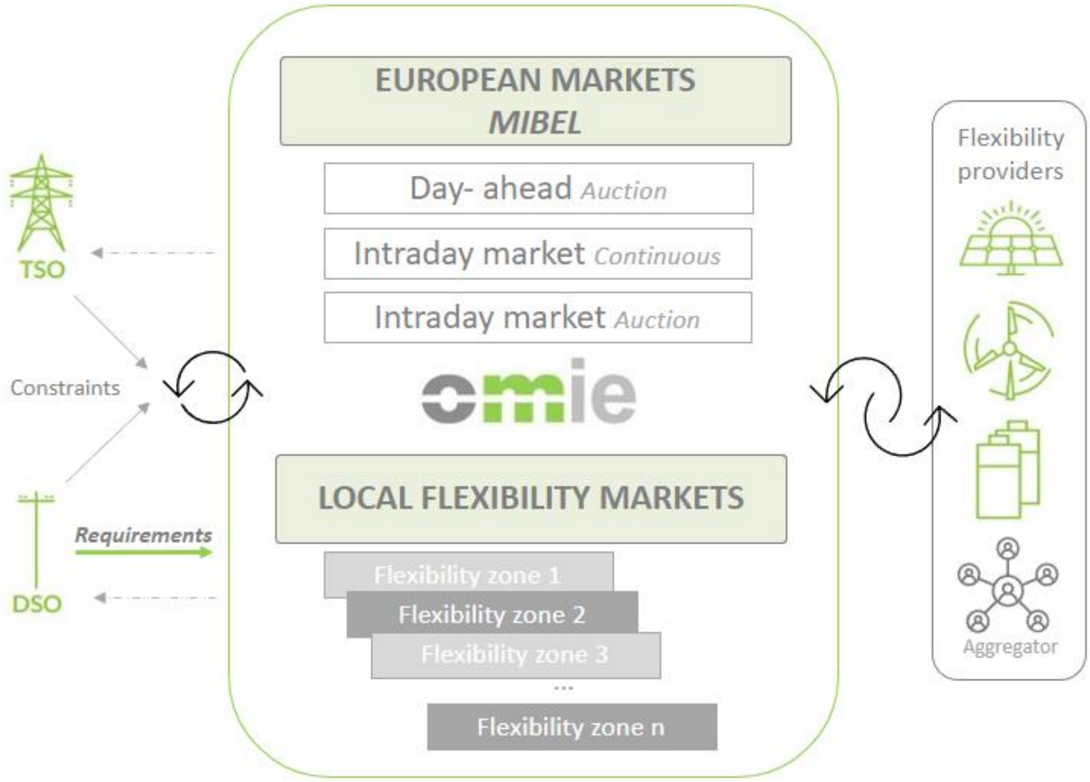

Figure 2: IREMEL Market Structure. Source: OMIE

2) Solving congestions in the distribution grid

Distribution networks have been designed decades ago for electricity flows in a single direction, from transmission to end consumers. Since then, electrification of usages (e.g., heat pumps, air conditioning, electric vehicles, …) has increased the flow of electrons on these networks. In addition, emergence of distributed energy resources (DERs), such as solar photovoltaics, has led to reverse flows of energy. At some times during the day, self-consumption installations can experience excess flows of energy that is fed back into the grid. With transformers, lines and cables not designed for these flows, congestion can arise (Canals Casals & Amante García, 2016). V2Market services will assist in congestion solving by managing the energy usage of EVs, located at the consumer-end of the network, where congestions stem from. Thus, V2B/V2G services enable the use of EV batteries as buffers that can soak excess energy or provide support in the management of local demand peaks.

In the BD4OPEM[1] project, congestion zones are reported and then the GIVe[2] platform from Nuvve identifies the EVs that can provide the required flexibility to address the congestion. This capability can then be offered on local flexibility markets and hence be monetized. The generalisation of these local flexibility markets will be a decisive advancement in the coming years, expanding the horizon of possible revenue sources through V2B/V2G services.

3) Decrease in new infrastructure and O&M costs for DSOs

The integration of renewable generation in the electricity sector implies the reinforcement and strengthening of the transport and distribution lines (i.e., nodes and interconnections) in the national territory to guarantee the security of supply and to avoid congestions in the voltage grid.

However, Eurelectric (2021) demonstrated that the cooperation of DERs and EVs can decrease grid expenses at the distributional level. Kandil et al. (2018) evinced that it can decrease costs by 75%, consistently avoiding energy losses. Moreover, the British Office of Gas and Electricity Markets, the body in charge of regulating energy in the United Kingdom, released a statement expounding that a distribution grid capable of using flexible DERs smartly, among other assets and upgrades, could in the long-term obtain savings amounting to £4.5 billion, which would have an effect on consumer bills (Brearley, 2022).

DSOs could benefit from operational and well-defined V2M services. The development of new business models and the optimal integration of electric vehicles, in particular V2G services, in the local flexibility markets could be an asset to increase efficiency, reduce energy transport losses and to avoid or postpone investments needed to reinforce the distribution grids.

The activation of local V2G flexibilities could contribute to solve operational grid constraints. V2G services could have a particular impact in urban residential areas with growing demand and in which high investments due to existing non-flexible configurations would be needed. Moreover, high investments in remote areas with limited infrastructure could also be reduced.

This capability of reducing grid expenses is a strength which will be key in order to decrease maintenance costs and grid operation costs, which the DSO would have to absorb in case no flexibility was provided from newly installed level 2 and level 3 chargers.

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[1] BD4OPEM. (2022). BD4OPEM: Big Data, For Innovative Energy Solutions. Retrieved from https://bd4opem.eu/

[2] CISION PR Newswire. (2016). Nuvve GIVe™ Platform, the World's Largest Aggregator Participates in TenneT's Frequency Regulation Market in the Netherlands. Retrieved from https://www.prnewswire.com/news-releases/nuvve-give-platform-the-worlds-largest-aggregator-participates-in-tennets-frequency-regulation-market-in-the-netherlands-300262624.html

2.1.3 Weaknesses for EV Owners and V2M Customers

1) Battery Degradation

V2G technology is likely to involve the frequent charging and discharging of EVs, which is feared that it may reduce the batteries' lifespan. While there is not enough evidence to establish the conditions under which battery degradation may occur, it is today a key EV owner concern. Battery degradation could make V2G a highly costly and unattractive service, as EV batteries are markedly expensive (Guo et al., 2019). However, degradation of the battery occurs primarily in the following two manners:

- Calendrical degradation: which does not depend on the charging/discharging pattern but from environmental variables such as temperature, humidity, air exposure etc.
- Operational degradation: which shows a complex yet close connection with the Depth of Discharge (DoD), average State of Charge (SoC) charging or discharging current, frequency of charging cycles, etc.

Nonetheless, V2Market services can also decrease operational degradation by:

- Operating the battery in the middle range of SoC: 20 up to 80%
- Slow charging and discharging cycles which, depending on the type of the battery, operates at 0.1 up to 1C-rate, where 1-C is defined as the rate of discharge which would discharge completely the battery in 1 hour.

2) Comparative Disadvantage of EVs in relation to ICEVs

The market entry of V2G and V2B services may be slow or limited depending on how the services compare to other mobility options. Today, several factors may position V2G and V2B in disadvantage to ICEVs. Beyond economic concerns exposed elsewhere, some may find V2G less comfortable for long-distance trips: EVs require more stopovers than ICEVs do, and the difference may be exacerbated by the use of V2G (Sovacool et al., 2018). Likewise, EVs often require a substantially longer charging time, which can be perceived as a hindrance or a constraint by users. As concerns private mobility, the range of model choice is also markedly more limited in the EV market than it is in the ICEV market (Figenbaum et al., 2015). Moreover, the payback time depends on the capacity of single EVs and fleets to adapt mobility to the grid's demands and their level of flexibility regarding parking schedules (Hu et al., 2019). This may dissuade potential EV Owners and V2M customers to make the first step into switching their ICEV for the electric alternative. For the purpose of exemplification, **Error! Reference source not found.** displays data on this topic from the US Department of Transportation.

3) Concerns and preferences: Cost, Reliability, Product loyalty, Range Anxiety

There are several user concerns that may dissuade potential customers from contracting V2M services. First, a body of literature documents recurrent user concerns over upfront costs of EV purchase and V2G and V2B installation (Thiel et al., 2020). Second, there is also an important bulk of data on user concerns over unpredictability regarding battery breakdown, the need for a replacement and its related economic costs (Sovacool, 2018). Third, the uptake of a novel, not widely known technology requires a high level of trust on the side of the user, as well as the renouncement to a potential sense of product loyalty regarding their previous mobility choices. Fourth, there are reported concerns over range anxiety: a perception of insecurity regarding whether a given battery level may be sufficient to reach a desired destination or the next charging station (Zheng, et al., 2017).

2.1.4 Weaknesses for Aggregators, ESCOs and DSOs

1) Lack of tested guidelines to allocate and size chargers

As of today, there are no widely endorsed tested guidelines regarding the allocation and sizing of charging stations (Danese et al., 2022). The lack of best-practices and experience of public (such as municipality and local energy agencies) and private actors (e.g., charging infrastructure providers) in the installation of chargers for public use, with or without a fee, constitute a factor which can hinder the scalability potential of V2M.

Furthermore, the present distribution of charging stations responds only to past and current mobility patterns. As such, to date planning has predominantly not incorporated considerations of future mobility patterns (Yu, 2019). This can hinder the project's capacity to provide an efficient service to end-users in the present, and especially in the years to come.

2) Limited and difficult installation of charging infrastructure

EV ownership and use are still today early-adopter phenomena[3]. The widespread adoption of EVs, and V2G and V2B technology will depend on the availability of charging infrastructure. In a reinforcing relationship, the fact that presently EV users are still a minority disincentivizes investment in charging infrastructure. Likewise, the reduced deployment of the latter also discourages the choice of EVs as the main mobility option of many[4]. The limited deployment

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[3] Buchmann, T., Wolf, P., & Fidaschek, S. (2021). Stimulating e-mobility diffusion in Germany: An agent-based simulation approach. Energies. Retrieved from: https://doi.org/10.3390/en14030656

[4] Danese, A., Torsæter, B. N., Sumper, A., & Garau, M. (2022). Planning of High-Power Charging Stations for Electric Vehicles: A Review. *Applied Sciences 2022, Vol. 12, Page 3214*, *12*(7), 3214.

of commercial or public charging facilities also could trigger a difficulty in finding charging points in some specific times of the day, when demand for parking slots as well as for charging power is at its peak (see Figure 3).

Moreover, the capacity for EV owners to engage in V2B/V2G will also be conditional on the grid's energy supply capacity in each charging point. As such, to install charging infrastructure may at times require an upgrade of an energy contract, and/or the replacement of the wiring in order to support a larger power supply.

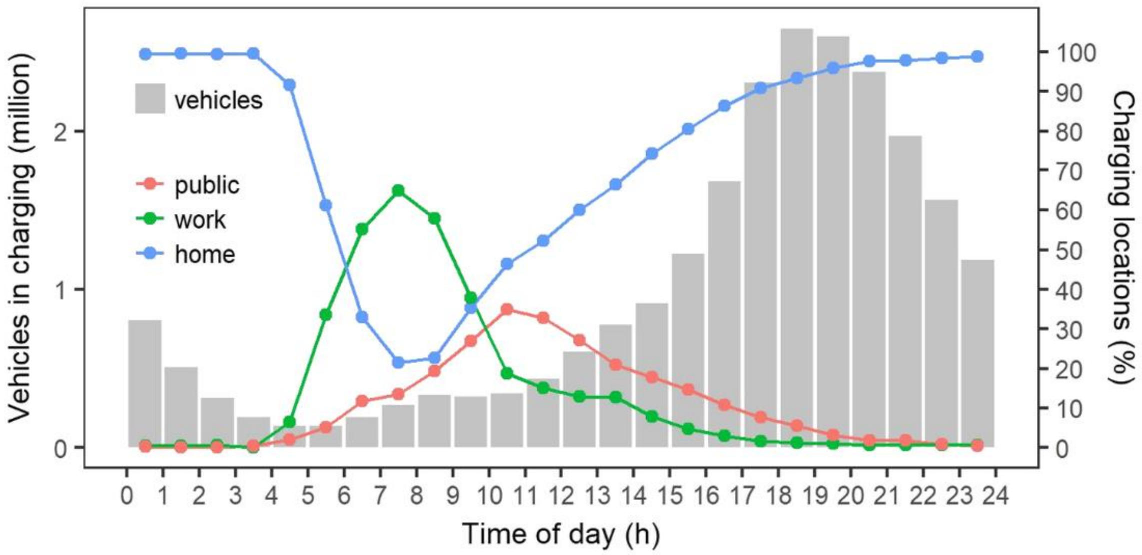

Figure 3: Vehicles charging in different locations: parking patterns can be an obstacle[5]

3) Power Quality Issues

The electric system can undergo power quality issues and significant power losses in the absence of proper harmonic pollution mitigation. Adding non-synchronous devices to a network increases the risks of eroding power quality, which can be affected by the quality of power electronics. Network operators might thus be reluctant to see the proliferation of bad quality devices on their grid.

V2Market will implement several ICT platforms: in this context it is very important to highlight that "GIVe" the V2G software developed by Nuvve and already implemented in several pilot project (one of which in Spain) will have to decrease this risk with proper software functionalities. Indeed, bidirectional chargers with high quality power electronics and full compliance with standards and norms, offer an opportunity to "sense" the network by monitoring the sinewave at its edges, adjusting P/Q (active and reactive power) and dampening oscillation by coordinating responses of EVs in a given area.

[5] Saber, A.Y.; Venayagamoorthy, G.K. (2011). Plug-in vehicles and renewable energy sources for cost and emission reductions. IEEE Transactions on Industrial Electronics, 58, 1229–1238.

4) Increase in infrastructure investment (transformers, lines)

The rollout of high-power charging station can cause congestions and an increase in the capacity of the grid, especially in rural areas, may require a renovation and an update of grid elements, such as transformers and lines which can no longer host the increased electricity demand.

To cope with higher electricity demand, system operators will have to invest to upgrade and reinforce grid elements in the affected transport and distribution networks. Future operational and maintenance costs will also increase. In particular, the need to collect real-time data of all supply points will require the digitalisation of the grid, including the full-scale implementation of functioning smart meters. Nonetheless, a correct dimensioning of the charging stations and the implementation of real load management measures and local flexibility markets could minimise the impact (World Economic Forum, 2022).

5) Lack of experience and infrastructure to participate in electricity market

Building on the experience and knowledge pool of the consortium of V2M, it is foreseeable that the first aggregators operating with V2B/V2G services may be companies with a deep knowledge of the market, especially those who already participate in electricity markets.

New figures and market participants will appear in the next years due to the definition of new actors in the market. Consumer empowerment will thus be key in the energy transition. European policies such as the Directive (EU) 2019/944 gives priority to encourage consumers to be active and to be part of the electricity market. Prosumers can trade their flexibility to the system, aiming to synchronise their consumption with time periods of lower energy prices by modifying their consumption, hence reducing their energy bill.

Another new figure involved in the electricity market are citizen energy communities and renewable energy communities. Member States must ensure that citizen energy communities can access all organized markets directly or through aggregation.

All these new actors in the electricity market will have to learn new concepts related to electricity markets and will have to get used to the electricity market platforms. Aggregators can manage the participation of prosumers in the market and provide simple and easy tools for the end-user.

2.1.5 Opportunities

1) Growing Public Environmental Awareness

Environmental sustainability features increasingly more prominently in the public policy agenda of international agreements and statecraft, as well as in civil society debates, activism, and daily choices (Wong, 2010; Kaul, 2019). This shift in perception and attitude across various types of residential, commercial, and industrial energy consumers can be an opportunity to commercialise V2M services to a wider market inasmuch as they are presented as clearly contributing to the mitigation of climate change and to the reduction of air pollution, and if the services are adapted to keep up with the advertised contributions to environmental sustainability.

Concurrently, the recent sustainable mobility trends of shared mobility, smart mobility, and product-as-a-service also constitute promising opportunities to commercialise V2M services more extensively. These increasingly demanded forms of mobility could be bundled in the range of services offered together with V2B and V2G and/or in the communication campaign for V2M services.

2) Using V2G to contribute to power system balance

V2M services make use of bi-directional chargers, which present a power converter that enables highly relevant functionalities such as the elimination of harmonic pollution or the injection of reactive power. With V2M services, EVs would be given the opportunity to participate in the provision of grid services such as voltage control, currently reserved to centralized generators.

Thanks to the very fast reaction times of batteries and power electronics, through V2B/V2G EVs can participate in the spinning of reserves and ancillary services such as frequency regulation. This is an opportunity for generators to free up capacity currently reserved to provide those services (Milstein & Tishler, 2019). It is also an opportunity to replace assets dedicated to power system ancillary services with services generated through V2B and V2G.

3) Agenda 2030: incentives to decarbonise mobility

The European Union has stipulated the goal of reducing its greenhouse gas emissions by 55% in comparison to its overall emissions in 1990, by the year 2030. As such, the Agenda 2030 implies a strong commitment with the decarbonisation of mobility, and it provides a set of targets and indicators to measure progress (EC Climate Action, 2021).

In this line, in December 2020 the European Commission released the Sustainable and Smart Mobility Strategy for the European Union, together with an Action Plan with 82 initiatives that will guide the first four years of the implementation of the strategy (European Commission, 2020). The Sustainable and Smart Mobility Strategy lays out several milestones that the Union aims to reach. As concerns electric mobility, the strategy establishes that by 2030, a minimum of 30 million zero-emission cars shall be in operation in European territory. Likewise, the Plan sets the goal that by 2050, almost all cars, vans and buses, as well as new heavy-duty vehicles, shall be zero-emission vehicles.

As part of this wider European agenda to transition to sustainable and smart mobility, 1,650 million € have been disbursed for the MOVES III, MOVES Proyectos Singulares, and MOVES FLOTAS programmes, following the European Commission's approval of Spain's Recovery, Transformation and Resilience Plan. These programmes intend to deploy various incentive strategies to promote electric mobility in the country between 2021 and 2023 (ICAEN, 2021; IDAE, 2021; IDAE, 2022). In the case of MOVES III, the programme will provide direct funding opportunities for the purchase of electric vehicles, and/or to support the development and implementation of charging infrastructure.

Overall, the strengthened European commitment with sustainable mobility, and the various programmes set in place to incentivise the large-scale uptake of electric vehicles constitute a promising and encouraging environment for the commercialisation of V2B/V2G services.

4) Recent and upcoming legislation

In Spain and in the European Union, new and updated regulation is being passed that enable a more extended operation of flexibility markets, as well as the integration of EVs in these markets.

At EU level, the Fit for 55 package proposed by the EU Commission in July 2021 (incl. the revised Renewable Energy Directive [RED III], the revised Alternative Fuel Infrastructure Regulation [AFIR]), the revised Energy Performance of Buildings Directive and the revised State Aid guidelines (CEEAG) recognise the role of EVs for a RES-based, flexible energy system and support smart charging functionalities through different provisions. In particular, the proposals mandate smart charging for all new normal power chargers (Mathieu, 2021).

As concerns Spain, on June 23rd 2020 the juridical figures of both renewable energy communities and independent aggregators were defined in Spanish regulation through Royal Decree Law 23/2020. However, it is pertinent to note that to enable the market participation of aggregators, the establishment of a full policy framework will have to be developed in the future.

In addition, on May 9th 2011, the regulation of the management of charging points for energy vehicles was established in the Royal Decree 647/2011. In the definition of the figure of the load manager, they act as market agents in the electricity production market.

Moreover, on the 8th and the 19th of March 2022 the Spanish government published two royal decrees to establish the rights and duties of charging points operators[6][7]. These decrees define the two juridical figures that shall be legally permitted to participate in charging activities: the charging point operator and the electric mobility service provider. In this manner, these decrees, which are aimed at expanding the protection of end-users, will contribute to the regulation, standardisation of EV charging activities. As such, they will both facilitate the implementation of a more extensive range of charging activities and bring clarity and security to EV users.

5) Increase DERs exploitation

V2Market services can create multiple benefits in terms of increased share of renewable in the system and integration of distributed energy resources (DERs). Through V2G and V2B technologies, EVs can provide ancillary services and solve congestion issues in the grid, therefore helping the grid to sustain and integrate a higher share of renewables. At the same time, V2Market services will allow the EV to charge when the electricity in the grid is cheaper and greener, therefore reducing peak demand during the day and increasing penetration of renewables. Grid connections and feeder capacities can thus be maxed out thanks to V2B and V2G as they unblock this buffer capacity. Finally, the interaction between the EV, the building and the grid will increase self-consumption and allow load optimisation especially with other distributed energy resources like rooftop PV installations. This has also been confirmed by research. Some authors investigated and simulated the increase in renewable energy production and self-consumption coupled with EV charging, and they concluded that V2G can support renewable energy production with a reduction in emissions and grid costs[8]. Likewise, Kandil et al. (2018) show that specific allocations of PV panels and EV chargers can decrease grid expenses by almost 75%, avoiding energy losses over time.

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[6] Ministerio para la Transición Ecológica y el Reto Demográfico – MITECO. (2022). El Gobierno aprueba la regulación de los servicios de recarga para vehículos eléctricos.

[7] Ministerio para la Transición Ecológica y el Reto Demográfico – MITECO. (2022). El Gobierno aprueba la regulación de los servicios de recarga para vehículos eléctricos. Real Decreto 184/2022, de 8 de marzo, por el que se regula la actividad de prestación de servicios de recarga energética de vehículos eléctricos.

[8] Saber, A.Y.; Venayagamoorthy, G.K. (2011). Plug-in vehicles and renewable energy sources for cost and emission reductions. IEEE Transactions on Industrial Electronics, 58, 1229–1238.

6) Trends in Charging Infrastructure and EV Sales

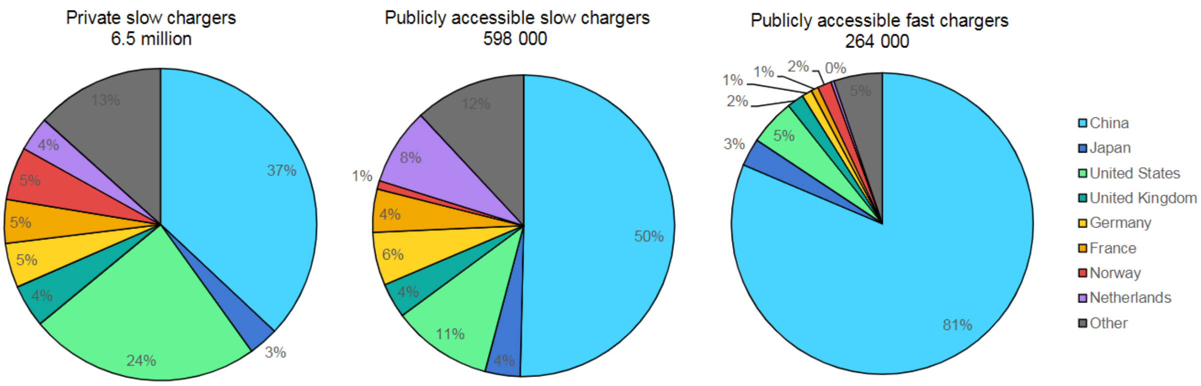

Figure 4: Public charging infrastructure installations from IEA EV Report[9]

Between 2014 and 2020, private EV sales have grown by 10% in the European Union. Crucially, despite the economic impact of the COVID-19 pandemic, the EV share of new car registrations increased from 3% in 2019 to 10.5% in 2020 (ACEA, 2021). These findings are partially explained by the recent market entrance of cheaper EV models. As EV price predictions suggest additional cost reductions in the near future, this trend is expected to be durable over time (T&E, 2021).

To assess the type of batteries which will be used in future energy market, Xie et al. (2018) have estimated that in the US, by 2030, EVs will represent 17% of all operative vehicles. Furthermore, out of this 17% of vehicles, 58.7% will be EVs with a 100-miles range, 41.1% with a range of 200 mile, and 0.3% will be EVs with a 300-mile range.

2.1.6 Threats

1) Lack of widespread knowledge about electricity markets, V2G and V2B technology

The functioning of the electricity markets, as well as the factors that shape energy price are unknown to wide segments of the European population (Aune, 2007). Similarly, EVs are today an early adopter phenomenon, and its functioning is comparatively less well-known than that of conventional vehicles. Moreover, as exposed previously, there are several documented user concerns regarding EVs.

[9] IEA. (2020). Global EV Outlook 2020. Global EV Outlook 2020.

Against this backdrop, V2G and V2B technologies constitute a mobility arrangement which responds to complex grid necessities and renewable energy particularities with which the general public may not be acquainted (Sovacool, 2018). This will impact the capacity of V2M to build user trust, and hence will have to be addressed through education and the implementation of a communication and information campaign that provides clear understandable answers to the listed user concerns.

Nonetheless, limited knowledge does not only affect end-consumer actions and attitudes, but also those of grid operators, who also struggle to keep up with innovations in energy management and research. As concerns V2Market, grid operators, who face the need of network reinforcement, are accustomed to investing in new transformers and cables and few may presently consider flexibility alternatives provided through V2B and V2G.

2) Slow market uptake and entrance of substitutes

As already mentioned, the transition to electric mobility alternatives is an early adopter phenomenon, with limited market penetration to date in the European Union. Engagement with V2G and V2B could slow down or be reversed if new, highly attractive mobility options enter the European market in the near future. Alternative low-emission solutions (e.g., hydrogen, or cheaper full hybrid vehicles) with a stronger offer in terms of comfort, price or bundle of services included could affect the long-term user engagement in V2G and V2B mobility schemes.

3) Mismatch between congested areas and flexibility resources

The participation of EVs in flexibility markets through V2M services envisions that, should there be a congestion on the distribution grid, local and flexibility markets will be activated by a signal launched by the DSO. It is possible that charger stations or points of plug-in for EVs may not match the congested areas. Consequently, the DSO will not be able to make use of the flexibility provided by EVs to solve the congestion.

Moreover, flexibility resources generated though V2M services will be able to participate in global electricity markets through the contract of an aggregator representing them in the day ahead and intraday markets. In this case, the absence, or residual character, of a regulatory framework, but also of long-established best practices to govern and manage transactions between these actors, can hinder or postpone the entrance of V2M-generated flexibility resources into these markets.

4) Data Privacy and Security

EVs participating in V2G and V2B schemes repeatedly share data concerning their legal identity, location, battery status, the stations they have frequented, and expected use with aggregators. The collection and distribution of these data is vulnerable to cyberattacks, with implications for personal data privacy, house assaults and the well-functioning of the grid (Saxena et al., 2017).

5) Lack of V2G user data segmented by social strata

In V2G literature, user behaviour, perceptions and knowledge are generally unaddressed. According to Sovacool (2018) topics such as gender norms, urban resilience, user vision and narratives, user behaviour and social justice concerns lack substantial academic engagement. The unavailability of such data is relevant to the implementation of V2M as it hinders the capacity to anticipate the distribution of costs and benefits across different social strata, and the various social needs and perceptions of accessibility and fairness that will shape the use of V2B/V2G.

6) Cost of charging (€/kWh) - Time of Use Electricity Price

Efforts to incentivise the shifting of EV electricity demand may be misguided and create peak hours. If this occurred, the congestion management benefits of demand response based V2G and V2B schemes might be counteracted (Raghavan & Khaligh, 2012). In electricity markets, tariffs and tolls must give a clear price signal to consumers and flexibility assets in order to manage and adapt their consumption or generation to the market needs. In case of EV owners, it is especially important to adapt their charging schedules to moments of low-price signals (due, for example, to renewable energy generation) or low-demand moments (for instance, at night).

The shifting of the demand from high price periods to low-cost ones will have a direct impact on the electricity market, but also in the cost of charging for EV users. If EV users adjust according to price signals, they will be able to save money on their energy bill and to maximize the benefits of having an electric vehicle.

7) Minimum access requirements

V2G allows EV owners to participate in the provision of ancillary services such as reserves, reactive power injection, frequency regulation and congestion management, among others. Nonetheless, to participate in ancillary service markets, V2M customers will have to attain or surpass minimum access requirements, which vary by country. As such, V2M customers owning one EV, as well as small fleet operators using slow charging, may not be able to fulfil minimum access requirements by themselves. Consequently, the revenue to be made through

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the contracting of V2M services may in the short-term only be available to large fleets, and especially to those using fast chargers.

Small fleets and individual EV owners shall be able to enter the market if they establish a contractual agreement with a flexibility aggregator, who may comply with the minimum access requirements by gathering the flexibility resources of numerous V2M customers. However, to do so aggregators must be legally permitted to operate in the countries in which there would be a substantial V2M customer base, a condition that is to date not present in all EU countries. As such, minimum access requirements may constitute a barrier to the commercialisation of V2B/V2G services among residential EV owners, and small fleets in several European states in the short and mid-run.

2.2 SWOT Infographic Overview

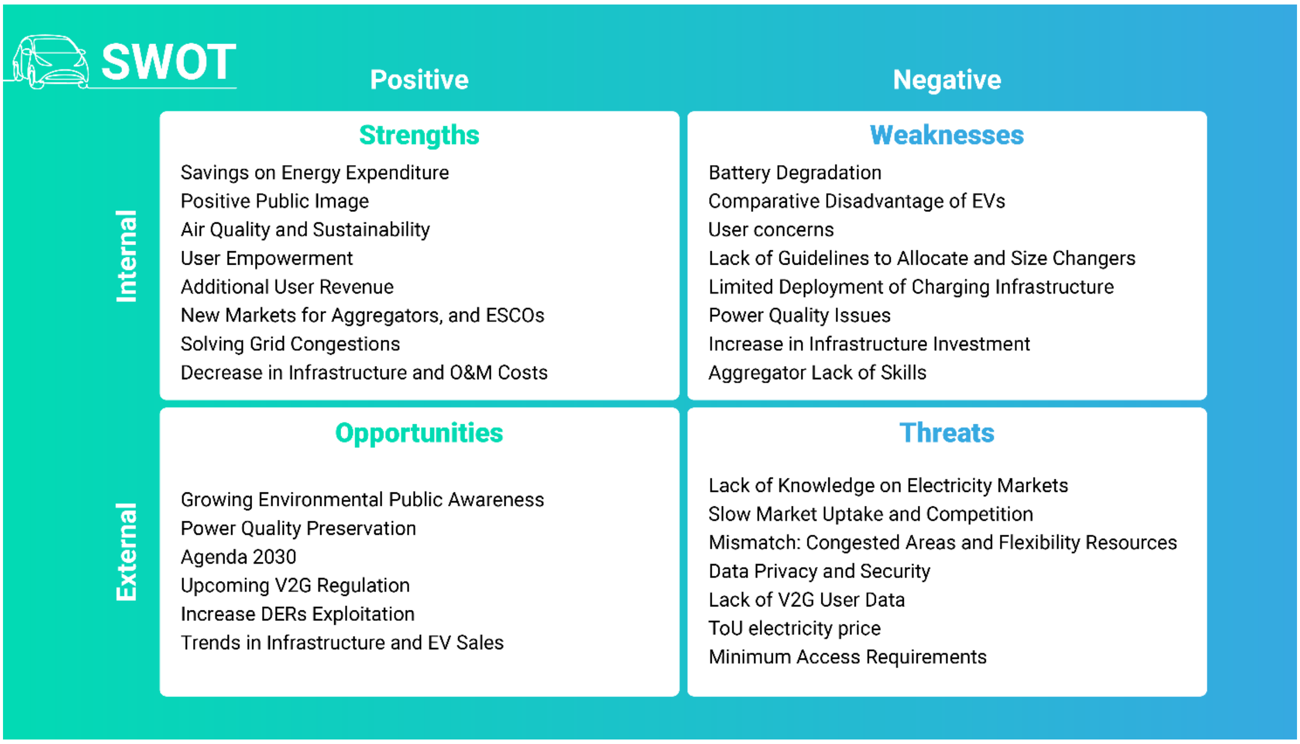

Figure 5: SWOT Infographic

3/ Customer Journey Canvas

A Customer Journey Canvas is a tool that provides insight in the customer experience of a given commodity or service (West et al., 2020). The canvas details the various forms in which the customer interaction with V2M services could take place over time: the circumstances in which interactions occur, customer behaviour, attitudes, evolving assessment of the service, and emotional responses. By documenting the manifold scenarios different types of customers may experience, a customer journey canvas can help the V2M to predict user reactions to its business case and can be used as a guide to adapt it to customers' views, needs, access barriers and preferences.

The Customer Journey Canvas of the V2M is structured in the following manner. Firstly, it builds on the SWOT study and on the pool of knowledge of the V2Market consortium to identify and define five user typologies. Each customer typology is established based on the sharing of similar technical features and constraints regarding the contracting of V2M services. These constituting characteristics are detailed in this subsection.

Secondly, a customer experience profile is presented for each customer typology based on the benefits and losses customers will experience as a result of contracting V2M services, the needs they want to fulfil through the services, and additional goals that customers want to advance through the contracting of V2B/V2G.

Thirdly, a customer journey canvas is elaborated for each customer typology. The canvas compiles the transition or lifecycle of a prototypical customer from the first moment in which they learn about V2M services, to the sustained reliance and purchase of these services over the long-term.

3.1 Customer Typologies: Technical Features

This section details the technical features that define each customer typologies. **Error! Reference source not found.** lists the definition composed for the five typologies.

Customer Definition		
1	Facility Manager	Building with charging point, functioning as a hub station for EV users
2	Public administration	Publicly owned charging stations and electric fleet
3	Private/Commercial fleet	Private entity in possession of both charging points and electric fleet
4	Physical person or household	One-person or multi-person household owning privately at least one EV and one charging point
5	Energy Community	One-person or multi-person households in possession of at least one EV, using a shared charging station

Table 1: Customer Definition

Error! Reference source not found. provides an example to illustrate each of the customer typologies listed above as well as the basic attributes that give internal coherence to each category.

	Examples	Vehicle Owner?	Building Owner?	Charger Owner?
1	**Shopping Mall**		X	X
2	**City Council**	X	X	X
3	**Private Fleet (e.g., renting agency)**	X	X	X
4	**Couple with children**	X	X	X
5	**Energy Community**	X		?

Table 2: Customer Attributes

Based on this initial customer typology segmentation, the following technical features were estimated for each of the categories. Because these categories encompass a broad and diverse range of actors, the estimations correspond to an average case.

1. **Facility Manager (e.g., a shopping mall):**
    a. **Number of chargers:** 5 to 50
    b. **Overall charging power:** normal chargers (level 2 – 22.4 kW):
    c. **Building electric demand peak power[10][11]:** 100 - 3,000
    d. **Daily number of cars served:** 50 - 500
    e. **Daily energy charged:** 20 kWh/car on average[12]
    f. **Daily energy discharged (potential):** 5kWh/car on average[13]

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2. **Public Administration:**
    a. **Number of chargers:** 2 - 50
    b. **Overall charging power:** 2 - 10kW/charger
    c. **Electric demand peak[14]:** 500kW
    d. **Daily number of cars served:** 10 - 50
    e. **Daily energy charged:** 20kWh/car, and up to 25 kWh if the energy discharged is replenished again in the administration's chargers
    f. **Daily energy discharged (potential):** 5kWh/car

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3. **Private/Commercial fleet (e.g., renting agency)**
    a. **Number of chargers:** 3 - 100
    b. **Overall charging power:** 2 – 7 kW/charger
    c. **Building electric demand peak[15]:** 700kW
    d. **Daily number of cars served:** 100
    e. **Daily energy charged:** Supposing an average of 30% of the cars being rented out, and 90km daily per car. This means approximately: 15kWh/car per day, which would entail 15 - 450 kWh/day. Added up with the replenishment of the discharged energy, total energy charged could amount to 1710 kWh/day.
    f. **Daily energy discharged (potential):** 40% of the battery capacity (assuming a 45kWh battery), imply 18kWh of discharge per car. That is, 1260 kWh/day.

[10] This shall be conditional on the building size. Fast charging shall not be required in urban settings.
[11] The energy charged corresponds to the sum of the energy discharged plus the daily need for driving (around 30km/day in Europe).
[12] The total energy charged might increase up to 25 kWh if the energy discharged is replenished again in the facility chargers. Nonetheless, since numerous facilities may not be the end-destination of many EVs, this additional energy is not included above.
[13] Considering that EV owners want to ensure at least a 10 kWh increase in charge.
[14] The estimation assumes that 20% of chargers will be capable of V2B, and that the remaining 80% shall constitute street chargers (V2G-only).
[15] Should the building at stake concern an agency, energy demand will be minimal, except for that required by the chargers. The estimation assumes that there may be two charging points in every building.

4. **Individual/Household owning an EV**
    a. **Number of chargers:** 1
    b. **Overall charging power:** 7.4 kW[16]
    c. **Building electric demand peak:** 6 kW
    d. **Daily number of cars served:** 1
    e. **Daily energy charged[17]:** 8~37 kWh, and up to a maximum of 57kWh if the energy discharged is replenished again at home
    f. **Daily energy discharged (potential)[18]:** 20kWh

5. **Energy community[19]**
    a. **Number of chargers:** 2~5
    b. **Overall charging power:** 1 charger of 22kW, and the rest of 7kW.
    c. **Building electric demand peak:** 50kW
    d. **Daily number of cars served:** 7[20]
    e. **Daily energy charged:** 8~37 kWh/car, therefore 56 – 259kWh in total. Total energy charged would amount to 399kWh if the energy discharged is replenished again in the chargers of the community
    f. **Daily energy discharged (potential):** 20kWh/car, which amounts to 140kWh

Error! Reference source not found. provides a comparison of the average estimations for the five customer typologies. While these parameters will have to be measured on a case-by-case basis, they will be decisive for the design of a technically and economically viable business model for customers belonging to any of the five categories. The consideration of these parameters can greatly help to thoroughly evaluate the involved stakeholders, their role in the economic and energy transactions, as well as the type of ancillary services that can be provided.

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[16] Wallbox Chargers SL. (2022). Quasar – More Power to You. Retrieved from https://wallbox.com/en_catalog/quasar-dc-charger
[17] It is worth noting that most EVs in Europe do not drive to an empty battery daily. The average distance travelled in Europe amounts to an estimate of 30km per day.
[18] According to the assumption that there shall be 1 (partial) cycle per day, charge off-peak, discharge at peak; plus ancillary services.
[19] Estimates correspond to an energy community of residential character.
[20] Considering an overall energy flow of 60kWh and an average parking time of 2 hours per EV.

	Customer Typology	Number of chargers	Overall charging power [kW]	Building electric demand peak power [kW]	Daily number of cars served	Daily Energy Charged [kWh/car]	Potential Daily Energy Discharged [kWh/car]
1	**Facility Manager**	5~50	22.4	100~3,000	50~500	20~25	5
2	**Public Administration**	2~50	2~10	500	10~50	20~25	5
3	**Private/ Commercial fleet**	3~100	2~7	700	100	15~33	18
4	**Physical person or household**	1	7.4	6	1	8~57	20
5	**Energy Community**	2~5	7~22	50	7	8~57	20

Table 3: Technical Characteristics of Customer Typologies

3.2 Customer Experience Profiles

This section introduces multidimensional user-centric profiles for each customer typology. These profiles were elaborated in multiple collaborative teamwork sessions held by various partners in the consortium. These profiles seek to shed light on the customer experience of V2M services, assessing them in terms of the advantages and disadvantages they represent for each typology. Specifically, these profiles encompass the following dimensions of the customer experience of V2B/V2G:

The technical features and necessities of a customer type

- The objective gains or benefits a customer will derive from V2M services
- The losses and/or the opportunity cost that is forgone by each typology because of the contracting of V2M services
- The needs that a customer wants to fulfil, and challenges they intend to resolve through the contracting of V2M services
- Additional goals the customer may want to advance entirely or partially through V2M services
- Common examples of each customer type

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3.2.1 Facility Manager Profile

Facility Manager: *Building with charging point, functioning as a hub station for EV users*

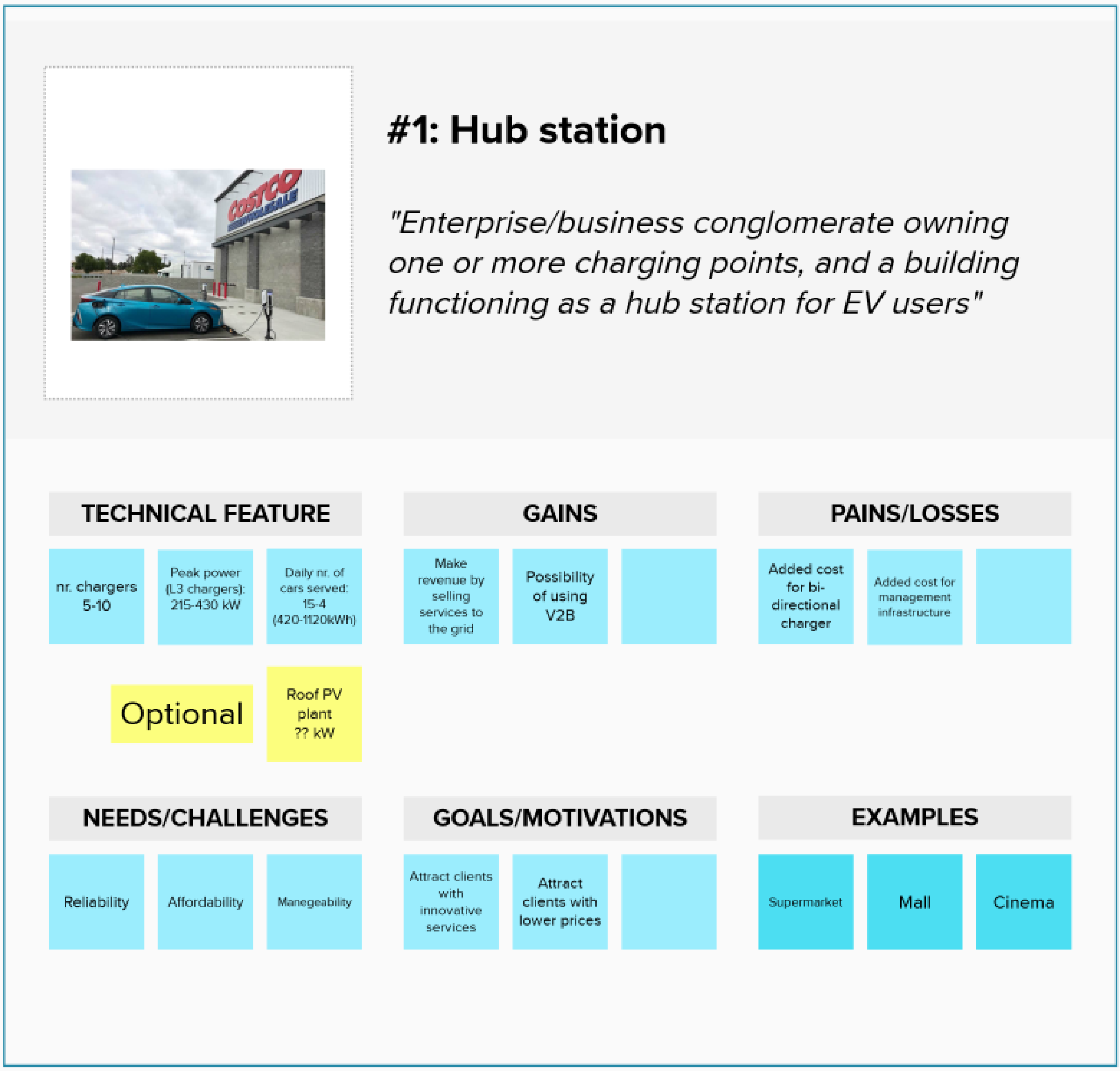

Figure 6: Facility Manager Profile

This type of customer is mainly characterized by having a large commercial, industrial or productive space with a correspondingly large parking space (e.g., a shopping mall, office building). EV charging can be offered as a premium service or for free to visiting EV users. For this type of facility managers, V2M services could help lower the charging cost to those parking in the facility. Moreover, the offer of free or premium charging could work as a 'stand-out' factor to attract more EV users and facility customers. For commercial facilities, being attractive to EV owners is paramount. For V2M services to be implemented over the long.-term, the benefits from V2B/V2G operation must be perceived by both the V2M customer – the facility manager – and their own customers – i.e., EV users –.

Low initial cost and reliable operation with low maintenance costs are the most important customer needs. Likewise, easiness of management for the facility manager, as well as for third parties (EV owners) stand out as relevant necessities.

- **Technical features:** The facility would count with 5 to 10 level 2 chargers (224kW), serving between 1 to 100 cars a day, depending on the facility typology.
- **Daily energy discharged (potential):** 20kWh/car on average
- **Gains:** With this service customers that park in a facility for medium-long stays may choose to obtain some economic revenue, either by participating in the flexibility market, or by using the available capacity directly in V2B mode.
- **Pains/Losses:** The charging equipment will likely have higher initial costs, alongside those of installation. In addition, there is the need to provide for infrastructure management as well as supervision for billing and market participation, which will entail added cost and layers of complexity.
- **Needs/Challenges:** For this customer, reliability and affordability are the principal needs. Additionally, the management system must allow for a flexible and parametric operation. For example, EV owners using the facility's chargers ought to be able to choose whether and the extent to which to (dis)charge their batteries based on battery charge levels, flexibility services demand and energy cost at any given moment.
- **Motivations/Goals:** The main motivation to use V2M in this scenario is to reduce a facility's commercial or industrial energy expenditure. In addition, for commercial facilities such as shopping malls, V2B/V2G can also be valued for the differential value they create, which may raise customer loyalty or expand the customer base.
- **Examples:** This type of customer are those that have a reasonably large parking space associated with a commercial space or travel terminal (train station, airport, …), with substantially long mean expected parking duration.

Since this business model involves both facility managers as customers contracting V2M services, and EV owners or users visiting the facility, the first customer experience profile is complemented with its 'EV user' counterpart. It is worth reminding that this complementary profile is specific to the interaction of individual EV users with a facility with contracted V2M services and ought not be mistaken for the Customer Experience Profile 4, which concerns individual or household EV owners that contract V2M services themselves.

EV owners or users: *EV owners/users who utilise charging points of facilities having contracted V2M services*

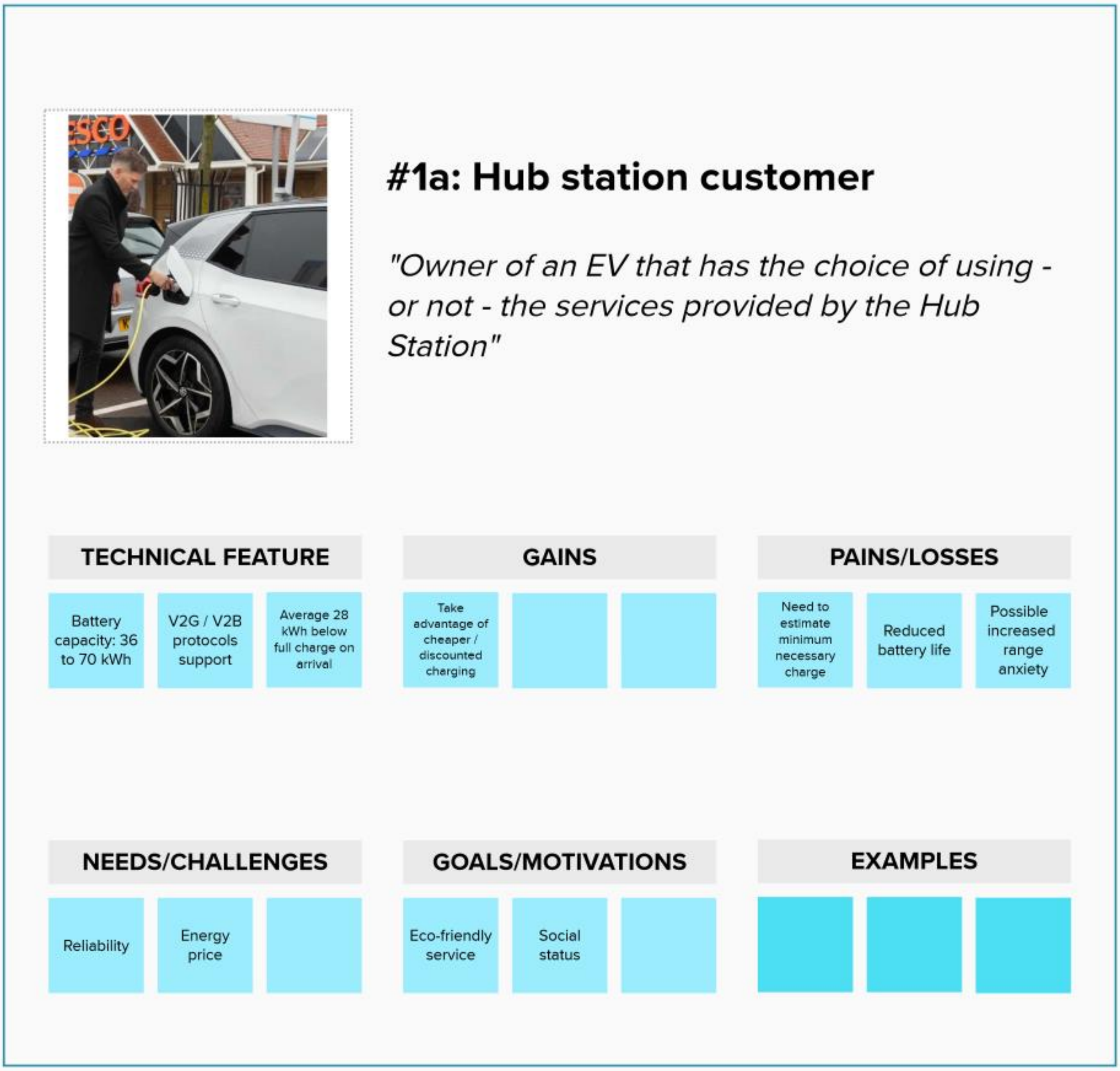

Figure 7: EV Owner customer of a facility equipped with V2M services

From the point of view of the EV owner that uses charging points at a facility providing V2M services, there is an opportunity to either charge the battery, or to use their energy surplus to gain additional revenue while having their EVs parked in the destinations they want or must visit. If the EV owner usually parks at that facility, the latter can offer V2M services in a subscription scheme.

Additionally, as concerns commercial facilities, motivations such as eco-friendliness or social status, may be present in the election to station themselves in a facility offering V2M services since they are likely to have already played a part in the decision to acquire an EV. This customer prefers a cheap and reliable service, that guarantees a minimum charge at a predefined time and is easy to interact with. The convenience it offers must be enough to overcome the widely reported fears of additional battery degradation, and increased range anxiety.

- **Technical features:** Battery capacity of 36 to around 70 kWh is about standard for private vehicles. To own an EV model suitable for bidirectional shall be a mandatory condition to use the service. The average "available" battery capacity per car, on arrival, has been estimated at 28 kWh.
- **Gains:** Compared to the alternative of charging at a regular rapid charger, V2M has the advantage that it can provide a cheaper charge, and/or to obtain revenue by having the EV simply parked.
- **Pains/Losses:** The driver will need to estimate how much charge will be required, in order to guarantee that V2M doesn't drain the battery below a safe level. This will in turn lead to possible increased range anxiety. From the point of view of hardware, accelerated battery degradation can be a relevant concern.
- **Needs/Challenges:** Reliability and charging cost are the main concerns from this customer's point of view.
- **Motivations/Goals:** To obtain revenue while being parked. Also, to get social recognition for being an opinion leader, and/or for engaging in the reduction of their own carbon emissions.
- **Examples:** Residential EV user, office worker, shopping mall customer.

3.2.2. Public Administration Profile

Public Administration – *Publicly owned charging stations and electric fleet*

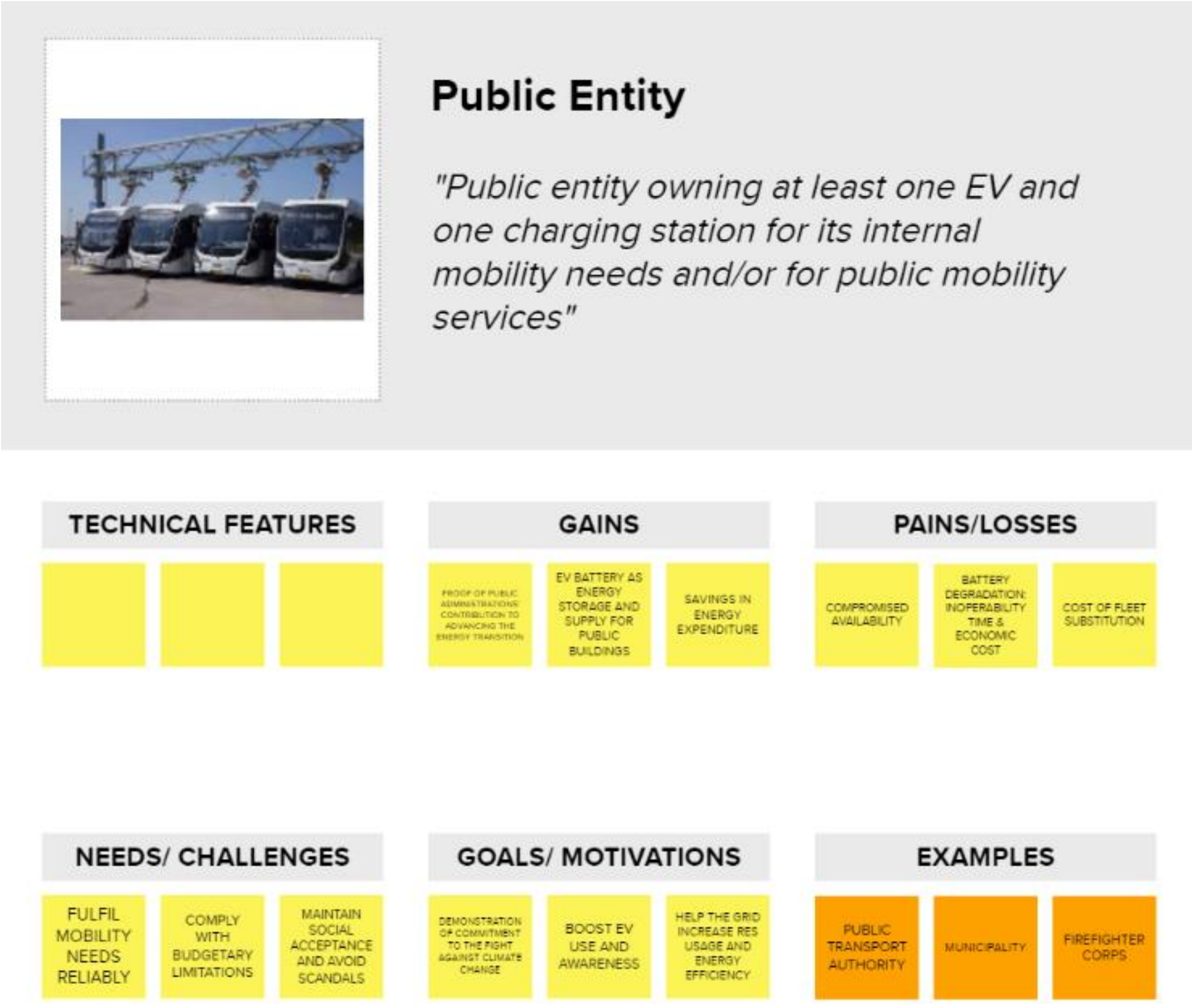

Figure 8: Public Administration Profile

- **Technical features:** This type of customer purchases fleet vehicles in accordance with the criteria of ease of maintenance, and best purchase conditions, often exhibiting highly homogeneous fleets (e.g., school buses).
- **Gains:** Nowadays numerous public administrations are obliged to some degree to reduce their carbon emissions and using V2M constitutes clear proof of such commitment. Economically, public administrations' interest in V2M services would be their capacity to increase their energy efficiency, especially through V2B, and to raise further revenues through the provision of services to the grid, or the selling of flexibility to aggregators.
- **Pains/Losses:** There is a trade-off between the benefits of V2M and available EV range. Battery degradation implies a limited range, and on the long run it has an impact on the cost of replacement. Another possible drawback is the need to replace the whole fleet to have V2M compatibility.
- **Needs/Challenges:** Reliability and affordability are the principal needs.

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- **Motivations/Goals:** Compliance with carbon emission reduction goals. Savings in energy expenditure.
- **Examples:** Public transport authority, municipalities, firefighter corps.

3.2.3 Private/Commercial Fleet Profile

Private/Commercial Fleet – *Private entity in possession of both charging points and electric fleet*

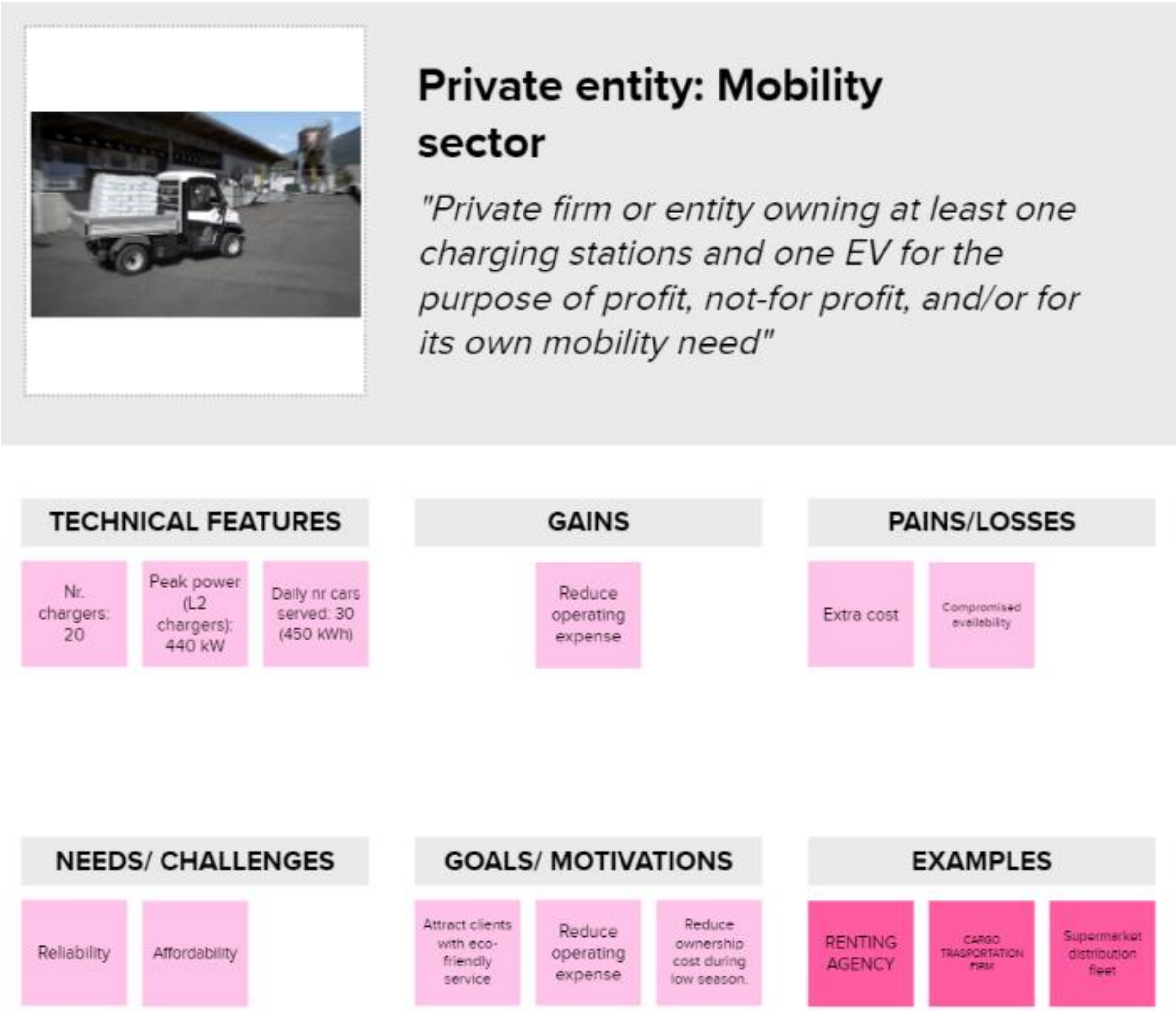

Figure 9: Private Entity Profile

This type of customer is characterized by having a fleet of EVs and a central hub with one or multiple chargers. Regardless of whether the fleet is operated for profit or not, the main interest in V2M services comes from a cost reduction perspective. In the case of the renting company indicated as example, V2M services could easily be used with the part of the fleet that remains stationed at the central hub at any given time.

- **Technical features:** 20 22 kW L2 Chargers serving 30 cars each day

- **Gains:** Use V2M income to reduce operating expense
- **Pains/Losses:** The extra cost of the system and of operation.
- **Needs/Challenges:** Reliable charging and low upfront investment.
- **Motivations/Goals:** The V2M service can act as an advertisement for an eco-friendly service. Reducing the operating expense is very important for any business, but particularly in a business which is subject to seasonality, maintaining some income level during low season can be a major benefit of V2M for this customer. As concerns renting companies, V2M services could also be an alternative to the usual reduction of the size of the fleet during low season periods.
- **Examples:** Renting agencies, cargo transportation firms or supermarket distribution fleets.

3.2.4 Physical person or Household Profile

Physical Person or Household – *Individual or household owning privately at least one EV and one charging point*

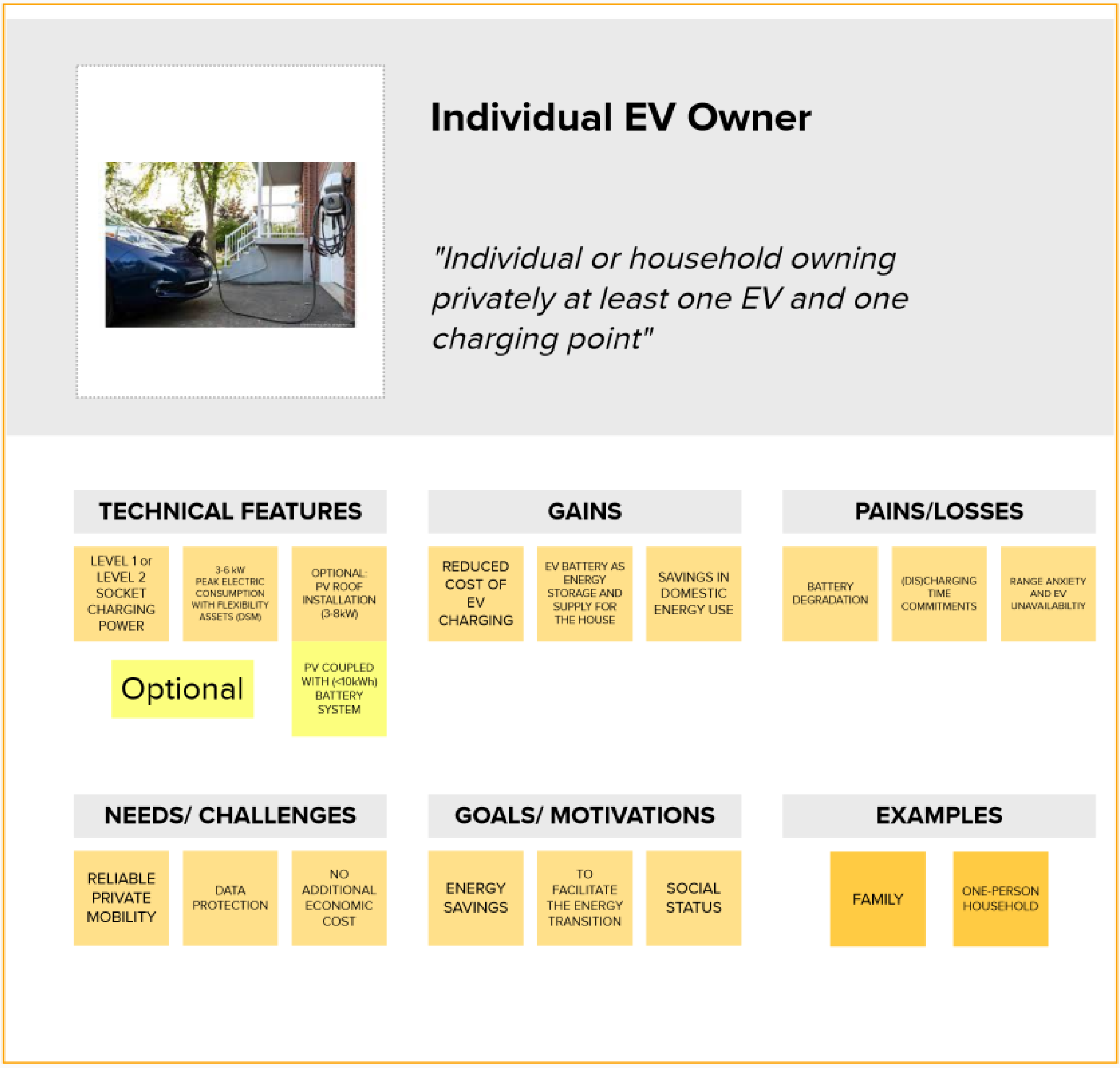

Figure 10: Household/Individual Profile

- **Technical features:** Level 1 or level 2 socket charging are more feasible due to their lower costs and power requirements. The presence of a PV installation on the roof of the house could be interesting for possibilities of integration.
- **Gains:** The cost of EV charging (as compared with no V2M services implemented) could drop, together with overall expenditure in electricity. The EV battery could serve as storage for the PV panels, in case they are present.
- **Pains/Losses:** Battery degradation is an aspect of fundamental importance for individuals owning an EV: they may have concerns that their investment in the battery is impaired by the degradation produced during V2M operations.
- **Needs/Challenges:** Data protection constitutes one of the most crucial challenges. A household may worry that the data collected through participation in V2M services could increase potential threats such as information theft (Tseng, 2012). Furthermore, another key aspect from the point of view of an EV owner may be the establishment of a contract that shall not subject to periodic payments. A periodic payment might be stipulated after an initial period that serves for the EV owner to have a clear understanding of his own routines and the impact that V2M might have on them.
- **Motivations/Goals:** Energy savings, social recognition, ecological footprint reduction.
- **Examples:** Families or one-person households.

3.2.5 Energy Community Profile

Energy Community – *One-person or multi-person households in possession of at least one EV, using a shared charging station*

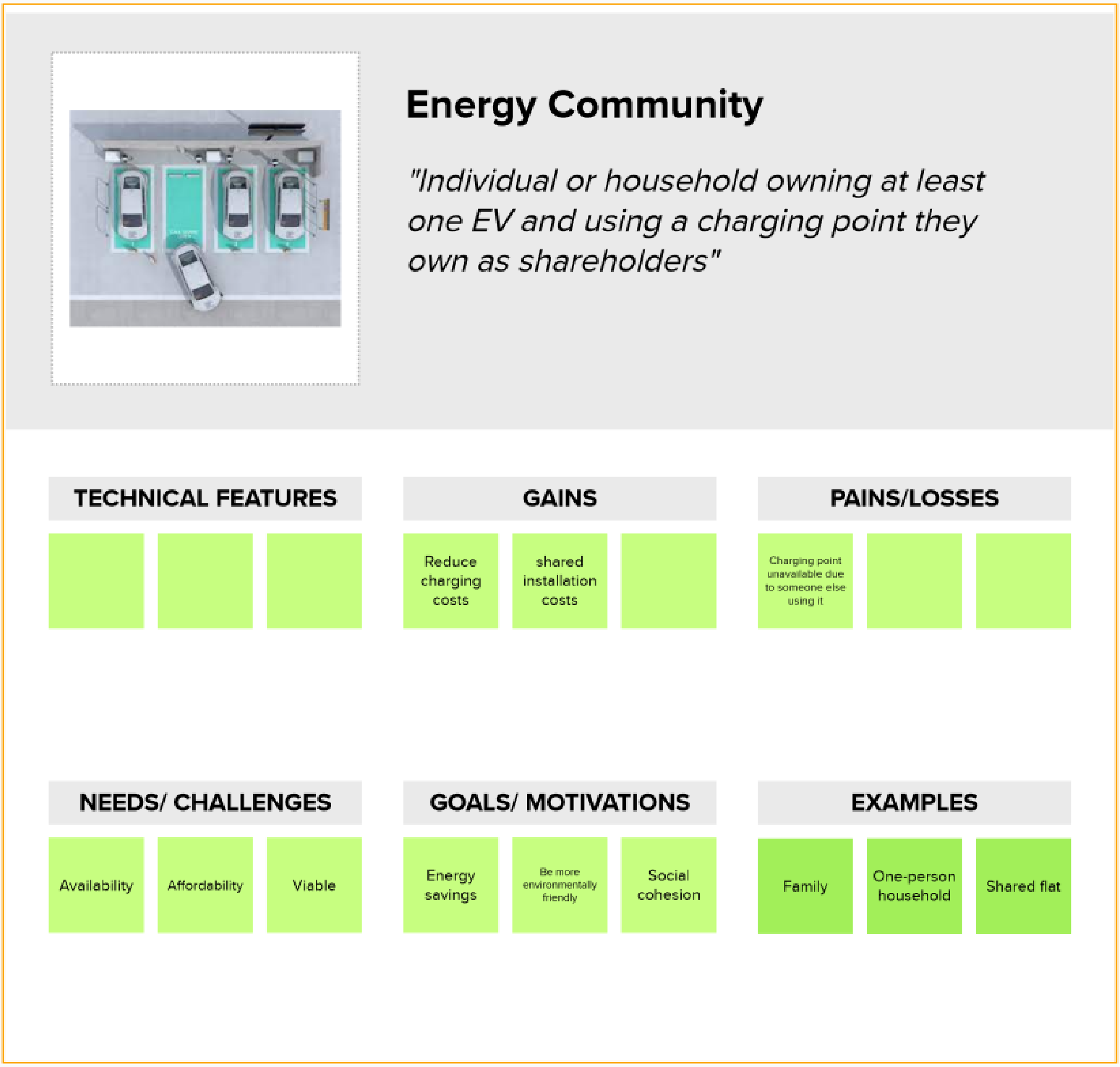

Figure 11: Energy Community Profile

- **Technical features:** This type of customer does not necessarily have homogenous technical features.
- **Gains:** By sharing the installation costs, an energy community may afford a shared rapid charger to complement, for example, a shared PV installation. This could constitute a relevant gain if different customer profiles participate in the energy community, and park for long periods at different schedules (e.g., a flat owner may park from 18:00 to 07:00, and an office worker from 08:00 to 17:00). V2M services also provide additional revenue that can serve to offset the cost of any energy imported from the grid, for example on overcast days or night-time charging.
- **Pains/Losses:** The need to share the charging point may imply that charging points might be unavailable when one user needs them.

- **Needs/Challenges:** The V2M operation viability depends on the regulatory framework around energy communities, which is still not fully developed and established. Affordability and reliability are paramount.
- **Motivations/Goals:** To use renewable energy to charge EVs and to use EV batteries as storage for clean electricity produced by the PV system.
- **Examples:** Families, one-person households, and shared flats.

3.3 Customer Journey Canvases

This section displays the final customer journey canvas composed for each customer typology. The canvases offer an overview of the customer experience and interaction with V2M services as it evolves over time. As such, the canvases constitute an extensive detail-rich documentation of the various circumstances that may lead customers to engage with V2M services differently over time, and they are intended to support the design of a business model for V2M services that is thoroughly informed about customers' needs, views and preferences, and that can hence be designed to befit these.

The canvases are structured in accordance with the temporal sequence of the phases that make up the V2M customer lifecycle, and which are represented in the horizontal axis of the canvases:

- The first moment in which the prototypical customer gains awareness of the existence of V2M services
- The process of seeking more information about V2M services
- An assessment of V2B/V2G in comparison to existing alternatives and substitutes in the market
- The choice and establishment of a contract for V2M services
- The user experience of the service
- The decision to retain or renew contract with V2M services

For each of these phases, the customer experience is disaggregated by the situations and actions that make up the lived experience of each stage; the various thoughts and considerations customers may have; their emotions and level of satisfaction; and the needs a customer seeks to fulfil at any given phase. The dimensions of the customer experience are listed in the vertical axis of the canvases.

3.3.1Facility Manager Customer Journey

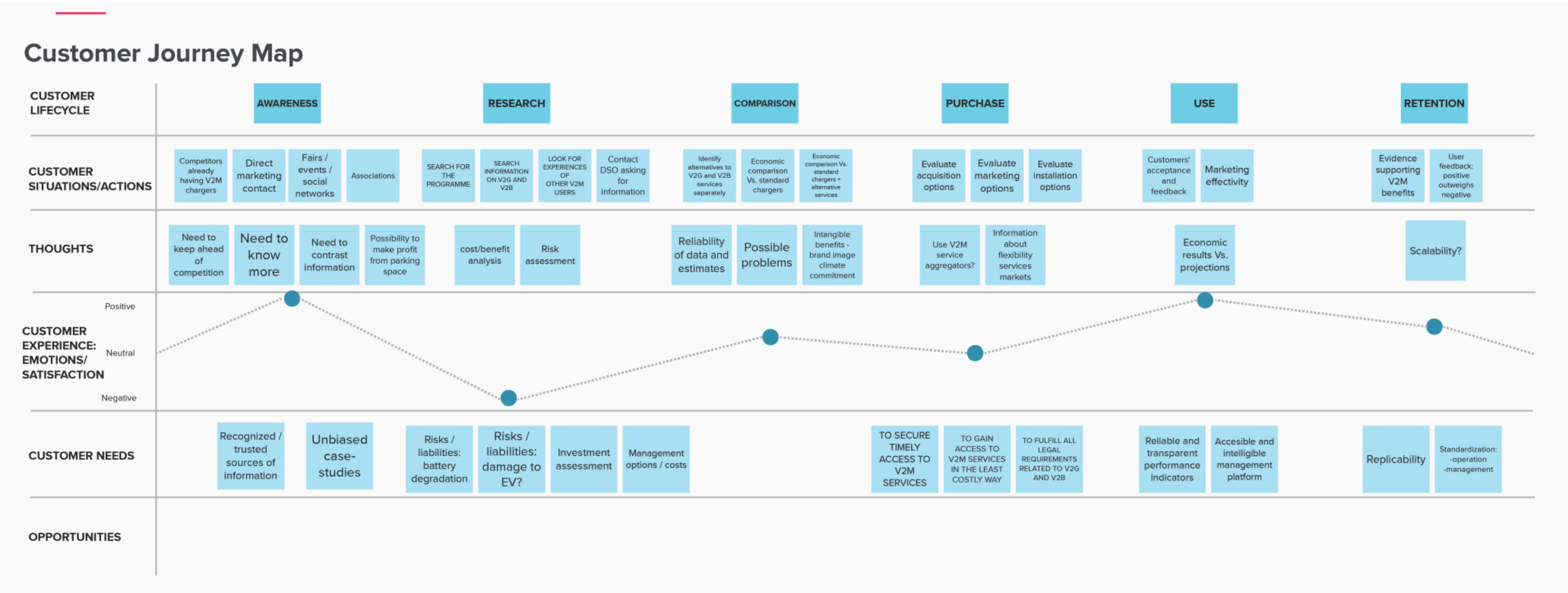

Figure 12: Customer Journey Canvas: Facility Manager

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3.3.2 Public Administration Customer Journey

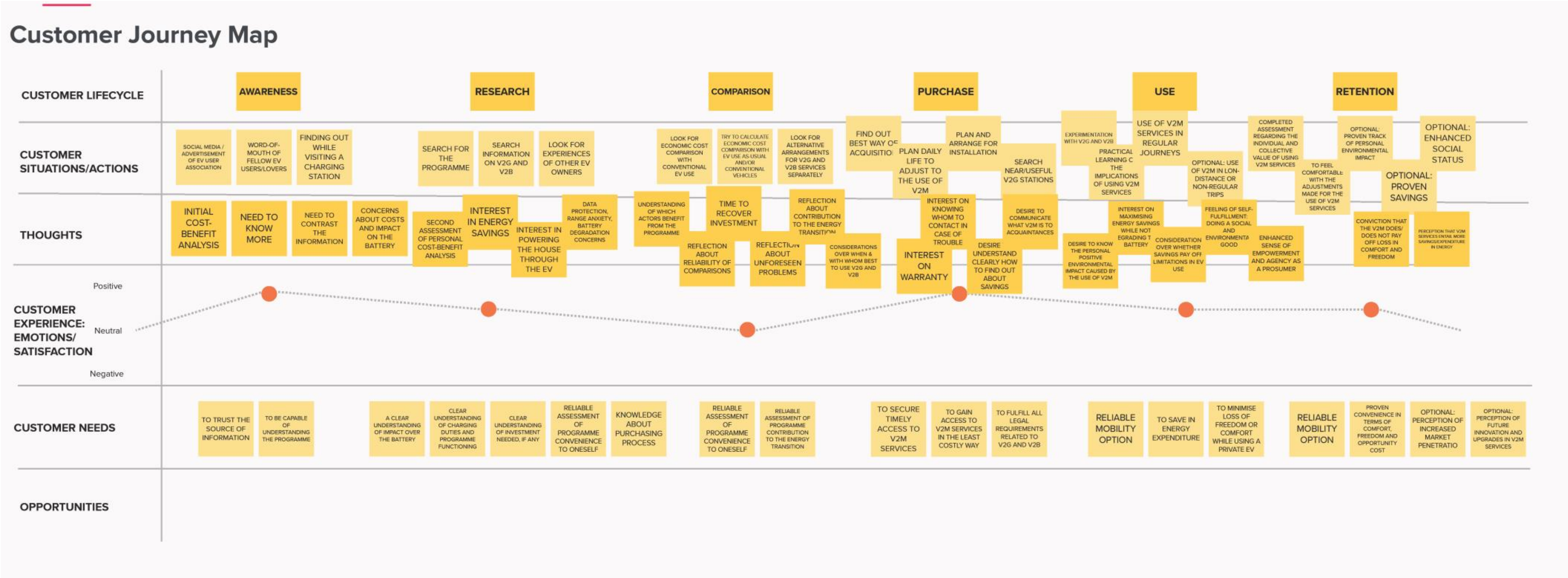

Figure 13: Customer Journey Canvas: Public Administration

3.3.3 Private/Commercial Fleet Customer Journey

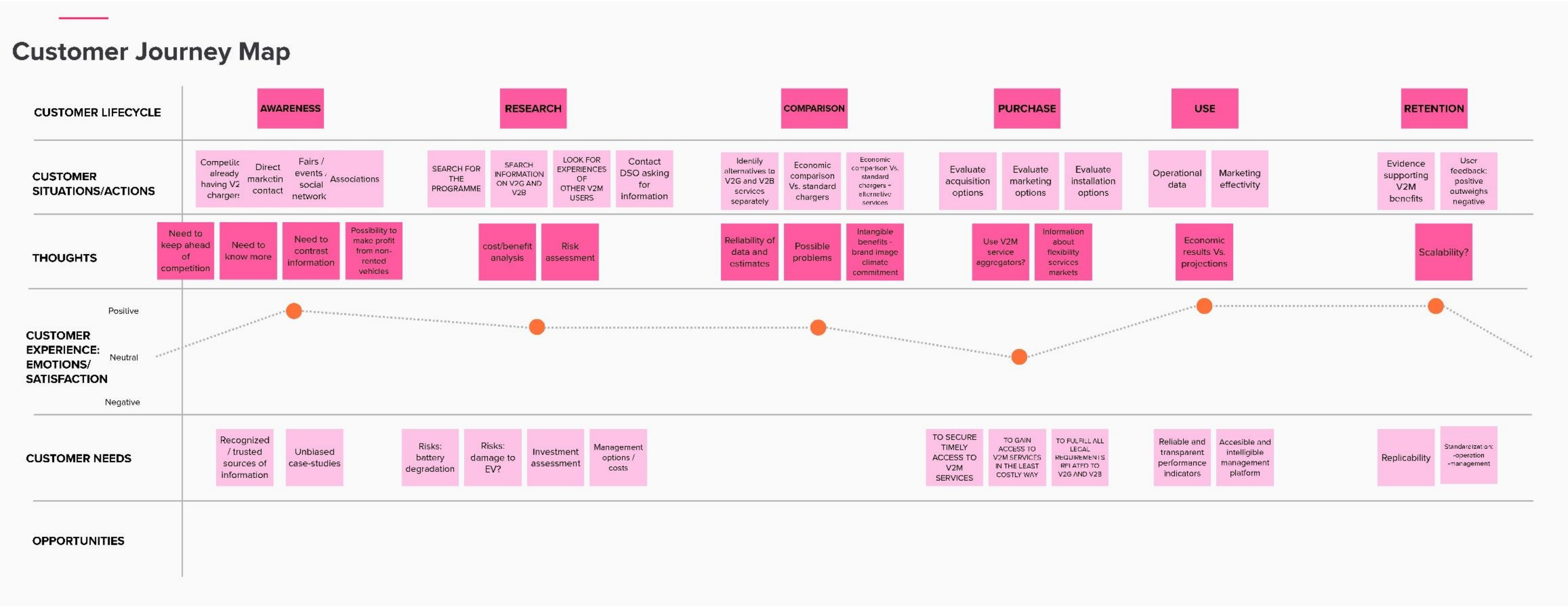

Figure 14: Customer Journey Canvas: Private/Commercial Fleet

3.3.4 Physical Person or Household Customer Journey

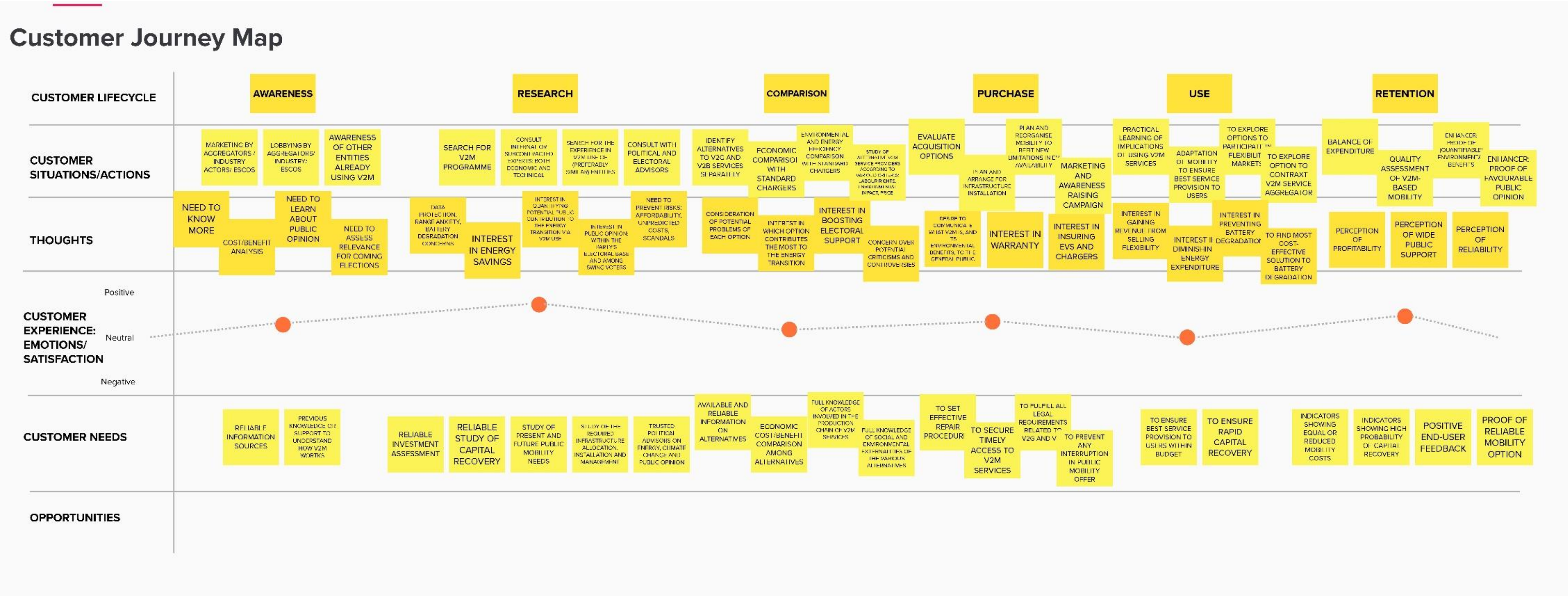

Figure 15: Customer Journey Canvas: Physical Person or Household

3.3.5 Energy Community Customer Journey

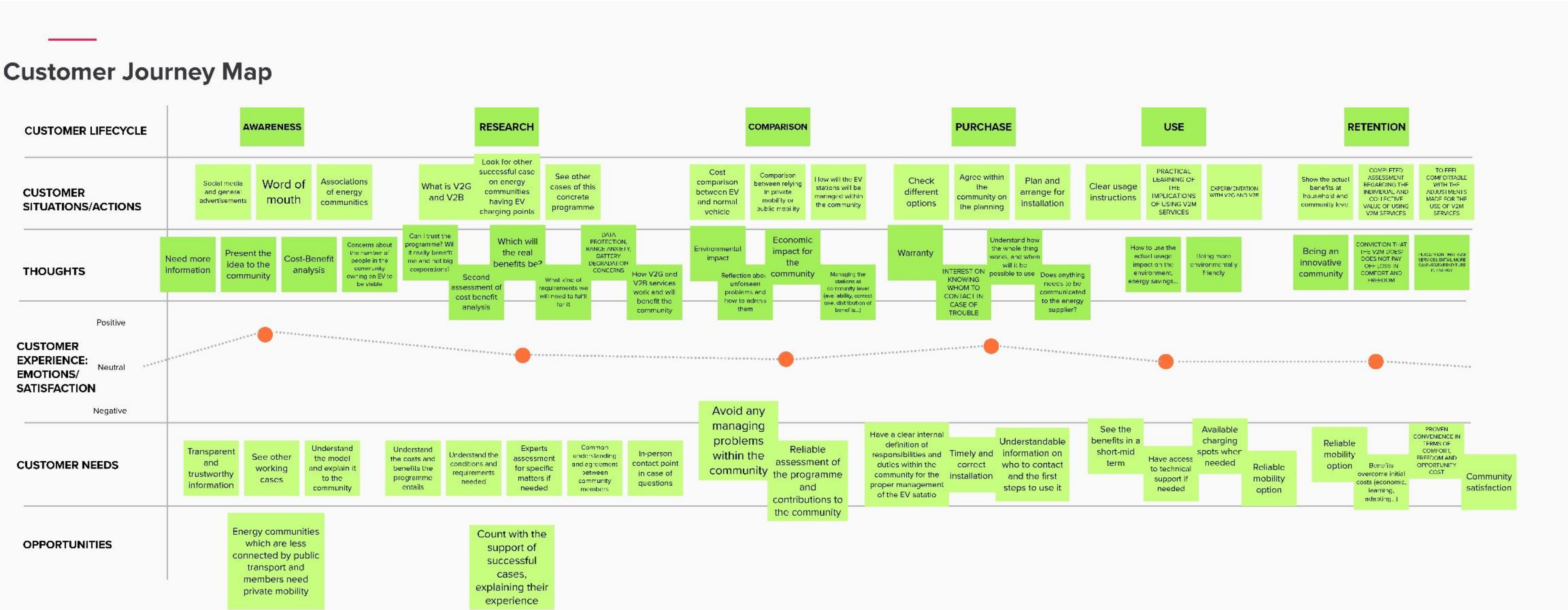

Figure 16: Customer Journey Canvas: Energy Community

4/ Conclusions and Next Steps

This deliverable has assessed the various factors that may decisively facilitate and/or hinder the commercialisation of V2B/V2G services in Europe. It has identified and highlighted the wide and diverse range of issues that affect the interest of engaging with a V2B/V2G business model of all key stakeholders: from individual EV owners to fleet operators, facility managers, aggregators, and DSOs. As such, it has stressed the need to take into serious consideration the valorisation that these stakeholders do of topics such as the social recognition attached to a commitment to reduce the respective personal or corporative ecological footprint, the widespread interest in predictable economic returns, or the possibility to reduce grid reinforcement costs through the provision of flexibility services, to name a few.

These findings in literature shall be tested and consulted with important market actors in the field of sustainable mobility and will guide the various activities aimed at elaborating an actionable business model for V2B/V2G services as follows.

Work Package 2: Market Study

The preliminary market assessment and comprehensive literature reviews provided in this deliverable will serve as guidelines to select the expert interviews and the focus group participants: the knowledge gaps identified in various strands of research, deliverable 2.2. will attempt to cover them by selecting research participants capable of contributing relevant insights on these. Finally, in deliverable 2.3, a synthesis of 2.1 and 2.2 will be conducted, in which the value that each of the top ten actors to be involved in the implementation and use of V2B/V2g will obtain from the services will be detailed.

Elaboration of an Actionable Business Model

The findings of WP2 will contribute a user-centric perspective to the other market diagnose tools that will be developed by the V2Market consortium: WP3's analysis of the electricity markets, and their present capacity to incorporate V2G service.

Likewise, the findings of this deliverable will inform both the design of financial schemes that shall be executed in WP4 and the multiple contractual arrangements to be composed in WP5, by contributing an assessment of each relevant actor's perspective and interests in the commercialisation of V2B/V2G, and the most likely gains and losses each may experience because of it.

Finally, D2.1 will be used throughout the remaining WPs as a resource to consult in order to repeatedly validate that the proposed business model is befitting to the needs, views, interests and material and technical circumstances of the various stakeholders of interest.

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