SCALE

Report on city needs & challenges in integrated planning for smart charging and V2X services

Project deliverable D1.3

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SCALE introduction

SCALE (Smart Charging Alignment for Europe) is a three-year Horizon Europe project that explores and tests smart charging solutions for electric vehicles. It aims to advance smart charging and Vehicle-to-Grid (V2G) ecosystems to shape a new energy system wherein the flexibility of EV batteries is harnessed.

The project will test and validate a variety of smart charging and Vehicle-to-Everything) (V2X) solutions and services in 12 use cases in real-life demonstrations in 7 European contexts: Oslo (NO), Utrecht (NL), Eindhoven (NL), Toulouse (FR), Greater Munich Area (GER), Budapest/Debrecen (HU) and Gothenburg (SE). Going further, project results, best practices, and lessons learned will be shared across EU cities, regions, and relevant e-mobility stakeholders.

SCALE aims to create a system blueprint for user-centric smart charging and V2X for European cities and regions.

SCALE's consortium comprises 29 cutting-edge European e-mobility actors covering the entire smart charging and V2X value chain (equipment and charging manufacturers, flexibility service providers, research and knowledge partners, public authorities, consumer associations, etc.). The project is led by ElaadNL, one of the world's leading knowledge and innovation centers in smart charging and charging infrastructure.

Matter of definition

Is V2G/V2X an integral part of smart charging or is it the next step in smart charging? It is a matter of which definition you follow. We consider V2G/V2X as the most advanced version of smart charging. Where smart charging starts at a basic level of load balancing between two sockets on one charging station, via advanced smart charging over hundreds of charging points in a building or in a neighbourhood, to highly advanced smart charging in the form of vehicle to grid (V2G) or vehicle to everything (V2X).

List of abbreviations and acronyms

Acronym	Meaning
AC	Alternating Current
CPO	Charge Point Operator
DC	Direct Current
DSO	Distribution System Operator
eMSP	e-Mobility Service Provider
EV	Electric Vehicle (Battery Electric Vehicles + Plugin-Hybrid Electric Vehicles)
ISO	International Organisation for Standardization
SCALE	Smart Charging Alignment for Europe
TSO	Transmission System Operator
V1G	(Unidirectional) smart charging
V2B	Vehicle to Building
V2G	Vehicle to Grid
V2H	Vehicle to Home
V2X	Vehicle to Everything

Report Executive Summary

Key words

City needs, City challenges, Energy network, e-Mobility, Zero Emission mobility, Smart Charging, V2G, V2X, EV Charging, Integrated planning, grid impact, smart grid, energy efficiency, government policy.

Summary

This report summarises the research conducted to assess city and regional needs and challenges in integrated planning for smart charging and Vehicle-to-Grid (V2G) / Vehicle-to-Everything (V2X) services. The research methodology involved collecting data from 37 survey respondents and conducting 17 interviews with a total of 19 interviewees, comprising stakeholders such as city and regional electromobility decision-makers and planners, Distribution System Operators (DSOs), and Transmission System Operators (TSOs). Additionally, the report draws upon relevant city needs and challenges identified through desktop research from academic and professional sources, as well as practical case studies.

The findings reveal that both cities and regions, as well as DSOs and TSOs, lack information and guidance on integrating V2G/V2X and smart charging into planning strategies, public space, related tender procedures, the grid, and hardware and software requirements to enable the next step of advanced EV charging infrastructure. There is a clear need for validated knowledge as well as for concrete examples and best practices to support integrated planning of e-mobility and energy systems and detailed requirements for smart charging in different cities and regions.

Key needs and challenges of cities and regions identified include:

1. **Charging infrastructure deployment and strategy**: Cities and regions generally have a strategy and vision for the deployment of public and semi-public charging networks on their territories. However, these generally do not always sufficiently forecast their impact on the grid. Few solutions, initiatives and pilots linked to smart charging or V2G are presented in these strategies as these are perceived as solutions for the future. Most cities and regions are focused on scaling up the deployment of market-ready charging infrastructure.
2. **Smart charging and V2G**: The deployment of smart charging technologies is critical for managing the impact of EVs on the power grid. However, many European cities and regions found it difficult to bring all the stakeholders required (private operators including CPOs, manufacturers, DSOs and TSOs, other levels of governance including region and national government, etc) to the table to cooperate seamlessly together.
3. **Governance and regulation**: European cities and regions governance and regulatory frameworks vary according to their maturity phase and national contexts. In some countries, like the Netherlands, there are strong national and regional initiatives to support municipalities, whilst in other countries, like Belgium or Spain, these frameworks are defined at a much more localised level. The establishment of clear and open standards for charging infrastructure and collaboration between stakeholders is highly dependent on these national contexts, however the importance of supporting interoperable, standardized, and open networks that facilitate EV users' charging experience is widely recognised by cities and regions.
4. **Grid constraints and energy management**: Many cities and regions who already have a scaling up or mature charging network are already facing the impact of EV charging. They are starting to develop strategies to shave the peak demand with or without incentives to charge at off-peak hours (e.g., night) and to test in localised streets or neighbourhoods of smart charging, V2G technologies, and energy storage systems. Their awareness of the issue is high, but just some cities have smart charging technologies adopted on large scale.
5. **Public and private sector involvement**: The integration of the private sector in the public charging infrastructure varies from European contexts. Some cities, like Barcelona and Madrid, have kept the

implementation, operation, maintenance and financing of the infrastructure public, while others like In Stockholm and Oslo have turned to the private or partly private. However, they recognize that the deployment of smart charging and V2G/V2X services does require collaboration between the whole ecosystem. So between public and private sectors, involving EV manufacturers, charging infrastructure providers, utilities, and other stakeholders. Every part of the chain must be present. There is a chicken-egg problem here: parts in chain wait for each other, especially when it comes to V2G.

6. **From the DSO and TSOs perspective:** The research highlights the critical role of grid operators in the successful deployment of EVs, smart charging, and V2X services, as they are responsible for various aspects of e-mobility, including grid development and charger connections. Many did smart charging and V2G pilots, but hardly any have scaled those up. So overall there is not much experience there. Prognoses and grid impact analysis is identified as a guess game for some, while others are confident about their prognoses and grid impact assessment. Addressing the challenges faced by grid operators requires collaboration, policy and regulation alignment, and stakeholder engagement. Conservativeness and being highly regulated is regarded by grid operators as a challenge for keeping up the pace in all the work needed.
7. **Front running cities and regions in smart charging and/or V2G** must make decisions about the future of the electricity grid in an increasingly complex environment. Faster exchange of information coming from different sources from different stakeholders (cities, electricity network operators, regions) is considered necessary to keep the quality of decisions at the right level. And to set the right priorities. A digital environment (tool) in which stakeholders can quickly and efficiently work on integrated planning, with regard to the electricity grid, is already being used by a few and is considered necessary by all e-mobility front runners in the research.

The report concludes with these recommendations to the European Commission and European cities:

1. Accelerate and scale up the dissemination of knowledge about smart charging and V2G/V2X services, including the establishment of an online knowledge centre.
2. Synchronise between cities and assess available digital tooling for providing a scalable European Integrated EV Mobility and Energy Planning Tool.
3. Solve the chicken-egg problem for smart charging and V2G, for hardware and software, with the policy 'super' power of the EU to develop:
    a. smart charging requirements at European level for public and semi-public charging stations.
    b. requirements for EV models to be V2G ready, starting with high end models.
4. Incentivize publicly accessible charging infrastructure on private land, with smart charging requirements as an additional condition.
5. Implement stricter energy efficiency policies for electric vehicles to reduce the pressure on the local electricity grid (and meanwhile conserve raw materials for EVs, including critical minerals).

Purpose of the deliverable

Attainment of the objectives and explanation of deviations

The objectives related to this deliverable have been achieved in full. After consultation with the representative of the European Commission, it was mutually decided to take four weeks extra time for the D1.3 report, so that more interviews could be done with the stakeholders and more input could be obtained for the report. For this reason, the initial deadline of the report has been moved from February 28, 2023 to March 28, 2023.

Intended audience

1. **European Commission** - This report contains recommendations to the European Commission (EC) to prepare the electricity grid for the massive uptake of electric transport by making it smart charging and V2G ready. They are therefore recommendations that can help the EC achieve its objectives with regard to the Green Deal. Especially recommendations 3 and 5 are recommendations for which the policy power of the EC could be strong if they were adopted in policy.

2. **European City & Regional Authorities -** Charging infrastructure that is rolled out today is expected to still be in operation within 10 years from now. Especially for charging infrastructure that is rolled out with the support of public money, legislators need to make sure that they can define requirements for the different actors so that it is able to meet the needs of the energy and e-mobility system of today as well as in the future.

   This report contains recommendations, information on strategies from different cities, and many resources that European cities and regions can use as a guide or inspiration. See chapter 3 needs & challenges and see the conclusions and recommendations.

3. **Grid operators - DSOs & TSOs in Europe -** The potential benefits to system resiliency, adequacy and congestion management that smart and bidirectional charging could offer to the transmission and distribution grid are to a certain point known to grid operators. But this report shows that also much is still unknown. There is a need for more specific knowledge regarding requirements for smart charging and V2G. And knowledge about the approach, results and lessons learned from various living labs.

   This report contains recommendations, information on how others are doing it, and many resources that also European grid operators can use as a guide or inspiration. See chapter 3 needs & challenges and see the conclusions and recommendations.

4. **SCALE consortium partners -** The entire chain of smart charging and V2G/V2X is represented in the SCALE consortium. The needs and challenges of European cities and regions are relevant to every party in the chain. Because the policy choices and strategies followed by European cities and regions (in direct collaboration with the grid operators operating there) have an impact on virtually all parties active in e-mobility.

   Therefore, the insights as presented in the results section of chapter 3 and the conclusions and recommendations derived from them are relevant for all SCALE consortium partners.

Structure of the deliverable 1.3 and links with other work packages/deliverables

The identified needs & challenges in integrated planning for smart charging and V2X services are input for work package 2.6: an Integrated EV Mobility and Energy Planning Tool.

Together with the results from task 1.4, outcomes of task 1.3 will also be input for WPO 5 in which a framework for Joint Procurement and planning (Task 5.4) will be developed.

Content

1. What is smart charging and V2G and why is it important?

1.1 Climate change and the environment

A shift away from unsustainable practices to limit climate change caused by greenhouse gas (GHG) emissions is critical. European countries have committed to reduce their carbon emissions in the coming decades. The EU has set a target of reducing GHG emissions by 55% in 2030 compared to 1990 base levels and aims to reach climate neutrality by 2050. The increasing penetration of electric vehicles (EVs) is supporting this transition: it has the potential to decarbonize both the transport and energy sector.

1.2 Electric vehicle growth

The transport sector was responsible for a quarter of European greenhouse gas emissions in 2016. As EVs can run on renewable electricity with low use phase emissions, switching to EVs can support the decarbonisation of this sector Over the past decade, the penetration of EVs in Europe has increased significantly, as Figure 1 shows. Policy measures aim to further increase the uptake of EVs. As part of the European 'Fit for 55' agreement, it was agreed to end the sale of new CO_2-emitting cars in Europe by 2035.

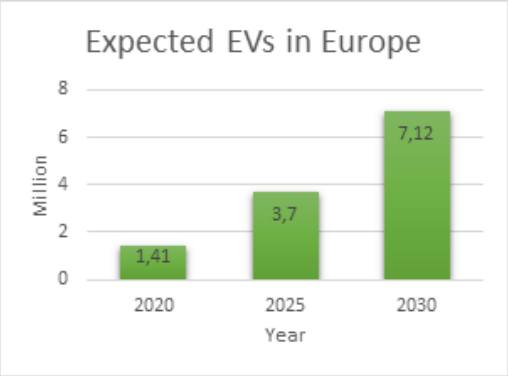


Figure 1. *The expected number of European EVs from 2020 to 2030 based on existing policies. Source: IEA (2021)*[1]

1.3 Challenges for the electricity supply system

The electricity grid currently has an average grid load of 20 - 30% of the maximum capacity. The shift to electric transport is already leading to an increase in electricity demand, both in terms of grid load and demand for energy. Without smart charging, the transition to electric transport will lead to increased charging peaks, for example when many EVs are connected to charging stations in the afternoon and evening when electricity demand is already high. In addition, the increasing amount of renewable electricity in the electricity grids needs to be balanced with the increased demand, taking into account the constraints of the electricity grid. Both the grid load and the variability of local sustainable electricity production call for smart charging of electric vehicles. This provides the opportunity to better match electricity demand and supply while taking into account the EV user's need for a charged battery.

[1] IEA (2021), Global EV Outlook 2021, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2021, License: CC BY 4.0

1.4 Types of smart charging

Smart charging of EVs can occur in several ways.

- In mono-directional smart charging, the speed and timing of the charging of EVs are varied, driven by either price incentives, grid constraints or local sustainable production.
- Bi-directional smart charging also allows for EVs to be discharged into the electricity grid or into applications that require energy.. Bi-directional smart charging can be used for a range of purposes. In the SCALE project, bi-directional charging or Vehicle to Everything (V2X) has been defined into four types based on its purpose: Vehicle to Home, Vehicle to Business, Vehicle to Depot, and Vehicle to Public (Grids).

In this report, the focus is mainly on Vehicle to Public, which implies a charging ecosystem that helps society to manage energy demand, alleviate local energy congestion and help reduce peak loads. The specific Vehicle to Public method to feed electricity from the battery into the electricity grid is called Vehicle to Grid (V2G). For an EV to be able to charge bidirectionally, bidirectional AC-DC converter hardware must be in either the EV with an Alternating Current charger (AC V2G), or in the charging station with a Direct Current connection to the EV (DC V2G). Both approaches have their own advantages. DC-V2G connects to the DC fast charging port that most EVs already have, and thus requires little extra hardware in the car. AC-V2G uses the ubiquitous Type 2 chargers which can be extended with V2G functionality relatively cheaply, making V2G charging better compatible to 'standard' charging and thus easy to upscale in the public domain. However, additional hardware is needed in each car for AC-V2G.

Figure 2. Bi-directional (AC V2G) charging points and roof with solar panels in the testing ground Utrecht Station area, The Netherlands

In general, the following applies: DC V2G currently requires more expensive charging stations than AC V2G which leads to significant extra costs per charging point. It is expected that this will remain the case, although these costs could drop in the event of mass production. AC V2G ready charging points currently only require a relatively small additional investment, compared to a non-V2G ready charging point with approximately the same specifications in terms of speed, phases, etcetera. It is relatively simple for a city to include V2G capability requirements in public tenders for AC chargers and several cities are already doing so. However, to be able to use AC V2G, EVs must be equipped with extra hardware whereas for DC V2G that is in principle not necessary. These dilemmas are the main reason why it is not yet clear which V2G technology will become dominant, or whether they will co-exist.

Smart charging, especially V2G, has the potential to solve some of the expected congestion problems on the power grid as well as provide ancillary services. In a nutshell, V2G creates a 'virtual power plant' (VPP) by pooling the batteries of a large number of V2G EVs operating in a coordinated way. This leads to a greater control on charging times (e.g. stop the EVs from charging during grid congestion or charge during high production of renewable energy) and a potential to use the batteries of the EVs By discharging them, to facilitate other demands of the grid. Analyses such as the one by Dutch grid operator Stedin (see Chapter 2 below) support this idea.

When upscaled, the benefits of V2G will be amplified by the law of numbers: in large fleets of smart or V2G charging cars and chargers, the behaviour of individual EVs and chargers will be damped out, resulting in more predictable behaviour and more reliable forecasts of the available flexibility at a certain moment. In several places in Europe, experiments are taking place with groups of smart/V2G charging stations providing congestion management services and/or procuring electricity on the day-ahead market, on the frequency markets, or reacting on variable grid charges.

2. Smart Charging & V2G in the public domain

In this chapter, more is explained about Vehicle to Public, which - as mentioned - implies a charging ecosystem that helps society to manage energy demand, alleviate local energy congestion and help reduce peak loads.

2.1 Grid reinforcements and public domain

The energy transition results in an increasing need for grid operators to reinforce the grid because of an increasing need for electricity. These grid reinforcements are time-consuming and costly. The long time period needed is caused by many factors including long approval procedures and shortage of labour force at the grid companies in certain countries. Furthermore, grid reinforcements require additional space in the cities for extra medium-voltage and distribution stations which tends to cause disruptions from having to open pavements and roads for cabling.

The EU has implemented regulation (CACM) to avoid unnecessary grid reinforcements. It aims at ensuring optimal use of the existing transmission infrastructure. To ensure network capacity is utilised more efficiently, physical grid congestions need to be managed by implementing congestion management methods. This EU legislation ensures that grid operators focus not only 'on cables and pipelines' when increasing the capacity of the electricity grid, but also on the implementation of digital technologies for grid optimization. This guarantees a stable and cost-efficient grid, built with physical and smart digital technology.

2.2 Smart and V2G charging to facilitate the energy transition

The expected electricity grid congestion problems can potentially be significantly reduced or at least postponed through smart charging and V2G. In Europe, the city of Utrecht in the Netherlands is a front runner on V2G in the public domain. It currently has the largest bi-directional ecosystem in the world and therefore much piloting and research has been done in this European city. This report therefore will present a few case studies from Utrecht in section 3.3.2.

The Distribution System Operator (DSO) in the Utrecht area, Stedin, has analysed the potential of smart charging and V2G for a part of the city of Utrecht, as shown in Figure 3. In this projection for 2035, grid congestion is expected in about a quarter of the low voltage transformers (red dots in the second figure: 48 out of about 200 transformers in overload). The ‘Smart Charging’ and ‘Super Smart Charging’ scenarios, on the other hand, partially reduce grid congestion. With V2G smart charging (rightmost figure), congestion is almost completely inexistant.

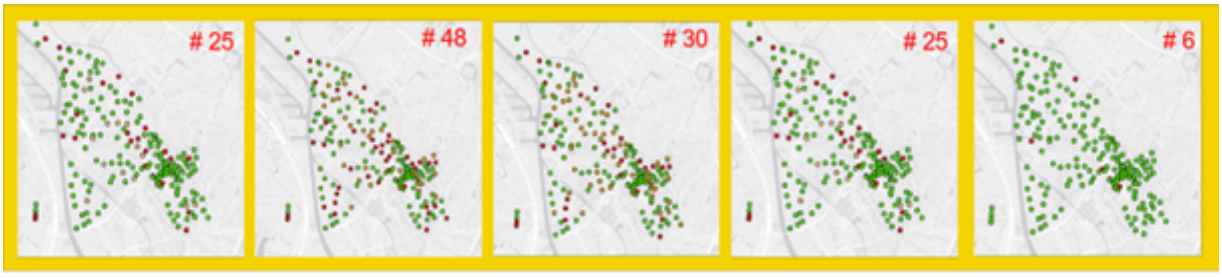


Figure 3. *"Opportunity Map" analysis drafted by Stedin. The opportunity map shows the spatial effect for Northwest Utrecht, as projected for the year 2035. : transformer substation with less than 80% load : transformer substation 80-100% load : transformer substation with more than 100% load # 48: number of overloaded transformer substations (in total about 200 transformer substations).*

This means that smart charging with V2G can greatly enhance the ability of the electricity grid and reduce or delay the need for grid reinforcements.

2.3 The potential of smart and V2G charging in the public domain

Also, a recent study conducted by researchers from MIT in the United States recognized the potential of V2G. The study examined a theoretical power system in New England that had strict carbon constraints. The researchers found that only 13.9 percent of the region's 8 million light-duty EVs could displace 14.7 gigawatts of stationary energy storage, resulting in a saving of US $700 million. The study also highlighted the role of EV batteries during peak demand, such as hot summer days, and the ability of V2G technology to inject electricity back into the system.

Research of the Utrecht University, based on the experience and data from the Utrecht living lab, offers further insight into the potential. Figure 4 from the paper *'Flexibility of Electric Vehicle Demand: Analysis of Measured Charging Data and Simulation for the Future'*[2] shows how the charging demand of EVs (as monitored in Utrecht) is concentrated in the evening hours, which might lead to overload on the grid. The colours indicate how flexible the charging demand is: most of the electricity demand could be postponed by more than 6 hours without any influence on the energy charged at the moment of departure of the cars, which means that this electricity demand could be shifted outside of the peak hours.

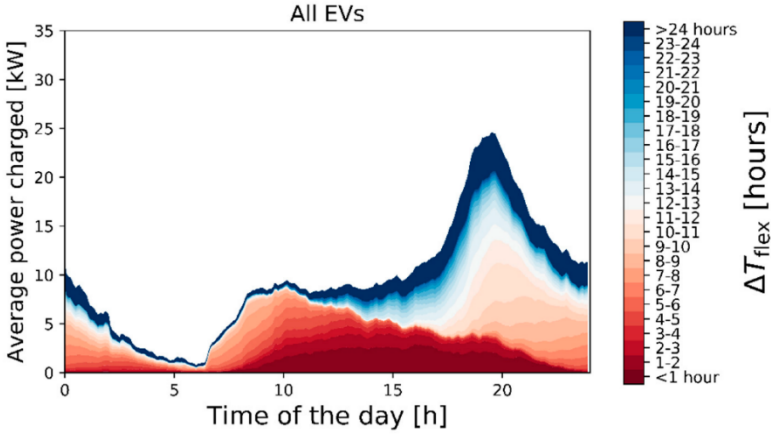


Figure 4. *Charging behaviour and flexibility in Utrecht. The colours indicate the number of hours that the electricity demand could be shifted without impact on the charged energy during the charging session. Source: Gerritsma et al. (2019)*[2]

Utrecht University analysed the costs and greenhouse gas emissions associated with smart charging and V2G. The study shows that smart charging and V2G charging can lead to both a significant decrease in charging costs and in CO_2 emissions, as compared to non-smart charging. Figure 5 shows this in a Pareto-frontier analysis:

[2] Gerritsma, M. K., AlSkaif, T. A., Fidder, H. A., & van Sark, W. G. (2019). Flexibility of electric vehicle demand: analysis of measured charging data and simulation for the future. World Electric Vehicle Journal, 10(1), 14.

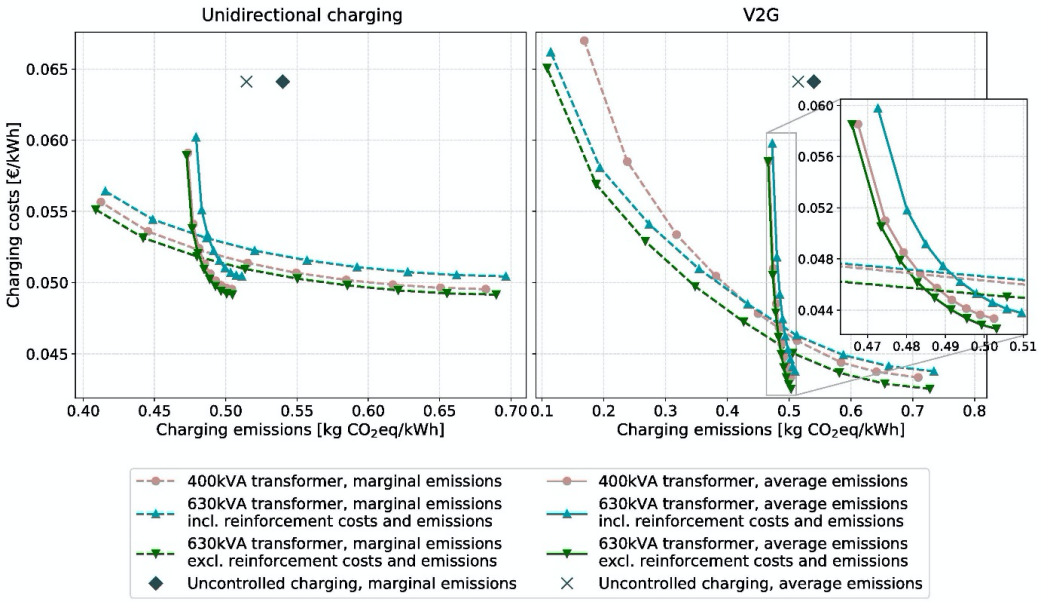


Figure 5. *Unidirectional smart charging (left) and V2G bidirectional charging (right) can be optimised between emissions (x-axis) and costs (y-axis) and have the potential to lower both costs and emissions significantly. Source: Brinkel et al. (2020)*[3]

Utrecht University also examined the business case for using smart charging and V2G to avoid grid reinforcement. This study used a model for electric vehicle charging in which EVs minimize electricity procurement costs in the day-ahead electricity market while ensuring that total electricity demand on a low-voltage grid does not exceed transformer capacity. This model was applied to two transformer capacity scenarios, 400 kW (current transformer) and 630 kW (upgraded transformer). The Lombok district in Utrecht was used as a case study. With a transformer capacity of 630 kW, EVs are less constrained by the transformer capacity to charge at times of cheap electricity, resulting in lower charging costs for EVs. However, in this scenario the transformer also needs to be reinforced, leading to social costs (to be incurred by the grid operator) for this reinforcement. In this study, the benefits of cheaper charging with a reinforced transformer were compared with the social costs for a transformer reinforcement. The results of this analysis are shown in Figure 6. The results show that in all scenarios studied, the costs of the transformer reinforcement are higher than the benefits for EV drivers to be able to charge less constrained by the transformer and therefore optionally cheaper.

For this reason, from a societal cost perspective, it is undesirable to reinforce a transformer if this can be avoided by implementing smart charging in a way that the quality of service for charging EVs is still good. And it is thus more desirable to delay or even avoid this transformer reinforcement through smart charging of EVs. When considering V2G charging, limited transformer capacity may not only restrict charging but also discharging of EVs. But even in that case, social costs are lower without transformer reinforcement, as portrayed in Figure 6. These results are valid for the Utrecht case study and may depend on e.g., future price developments.

[3] Brinkel, N. B. G., Schram, W. L., AlSkaif, T. A., Lampropoulos, I., & Van Sark, W. G. J. H. M. (2020). Should we reinforce the grid? Cost and emission optimization of electric vehicle charging under different transformer limits. Applied Energy, 276, 115285.

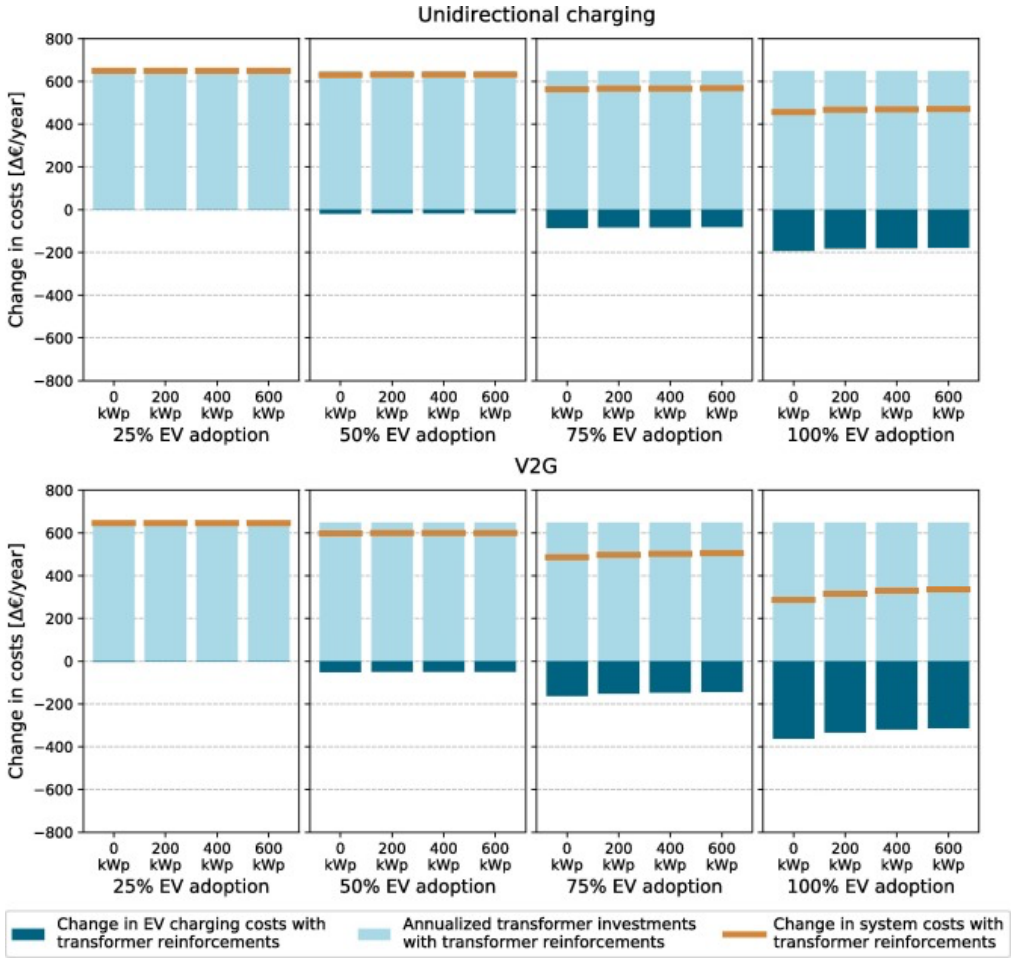


Figure 6. *Comparison between grid reinforcement costs (light blue bar) and benefit in charging costs (dark blue bar) when transformer capacity is increased from 400 kW to 630 kW with different charging scenarios. Source: Brinkel et al. (2020)*

Conclusion

The above analysis shows the potential for smart charging and Vehicle to Grid to not only reduce electricity grid network congestion problems, but also reduce greenhouse gas emissions associated with the electricity for the EVs, while potentially offering a way to delay or avoid electricity grid reinforcements, and with these lower societal costs. Additionally, this also avoids unnecessary labour of technicians in markets in Europe where there is a shortage of technical professionals in this field. As a result, that labour can be deployed in places elsewhere.

3. Needs & challenges

As a reminder, this study focuses on 'Vehicle to Public (Grids)'. Almost 50% of EU's population lives in apartments[4] which mostly leaves EVs to be parked at on or off-street parking. SCALE will implement and test ecosystems of smart charging and V2G that will help municipalities to manage energy demand, relieve local congestion, and support reducing peak loads. This chapter assesses the needs of city and regional planning related to smart charging & V2G/V2X.

3.1 Research Methodology

We assessed city and regional needs and challenges in integrated planning for smart charging and V2X services. To this end, a survey and interviews were conducted to collect data on needs and challenges of stakeholders, particularly city and regional planners and decision-makers, DSO, TSO and the added value of smart charging and V2G in cities.

For methodological as well as for practical reasons, we decided upon further consideration to conduct 17 separate interviews (and with that a total of 19 interviewees, because two were interviews with two people at once) instead of focus group interviews. This allowed us to collect more and more in-depth information, even if it took more time. And practically, we found out focus group interviews were difficult to organize due to the busy schedules of all respondents.

The cities and regions were selected for the interviews to ensure a good comparative overview by selecting on geographical spread, maturity and population size. After conducting four interviews, a selection of additional cities was made according to the initial findings and potential comparative potential. A few insights resulting from the choice of cities to interview are elaborated on below.

- Public decision makers and professionals in the electric mobility ecosystem from **Madrid** (City Council and EMT Madrid) and **Barcelona** (Barcelona Regional) allowed us to establish a comparative analysis of two major cities within the same country with a similar deployment of charging infrastructure (average)
- City officials from **Leuven** and **Arnhem**, two small-medium sized cities of BENELUX, showed us the role of cities in collaborating with other levels of governance (region) and proximate cities in order to deploy public charging infrastructure networks.
- The regional perspective of the **Province of Utrecht** and the academic perspective of **MOBI VUB**, who support the region of Brussels-Capital in their strategic charging infrastructure plans, brought insights in a regional approach on expected bottlenecks for energy infrastructure, sustainable generation, housing, large logistics companies, bus sheds, development of the charging network for passenger transport etcetera. And the need for an integrated planning for this all.

[4] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210521-1

- The Northern capital cities of **Tallinn, Oslo** and **Stockholm** showcased the diversity of public charging infrastructure challenges and approaches that are highly linked to their maturity phase in this sector.

Next to the survey and the interviews, we report on relevant city needs & challenges that we have identified in numerous online resources, such as reports, articles, etcetera. And we report on how these needs & challenges can be addressed. We also draw on the authors of this report's own professional knowledge and practical experience.

3.2 Findings from our research

This chapter contains the results of our research. These are reported in sub sections per research method:

- **3.2.1 Survey outcomes**
- **3.2.2 Interview outcomes**
- **3.2.3 Lessons from European best practices**
- **3.2.4 City needs & challenges regarding smart charging & V2G from authors experience and knowledge: Case Studies**

3.2.1 Survey outcomes

Overview of respondents

37 respondents completed the survey. 24 of the 37 respondents are city officials or officials from a regional authority. And 13 of the 37 are working at distribution system operators (DSOs) or transmission system operators (TSOs). The survey was conducted from December 2022 to February 2023. A total of 16 countries were represented in the sample. The countries most represented were the Netherlands and Germany, with five respondents each (14%), followed by Spain and Sweden, with four responses (11%). These five countries accounted for 61% of all responses in total.

Furthermore, 40% of respondents reported working in geographical jurisdictions with more than one million inhabitants. In second place came areas with 500.000-1 million and 250.000-500.000 people, with 20% each. Areas with less than 50,000 represented 3%, i.e., only one response.

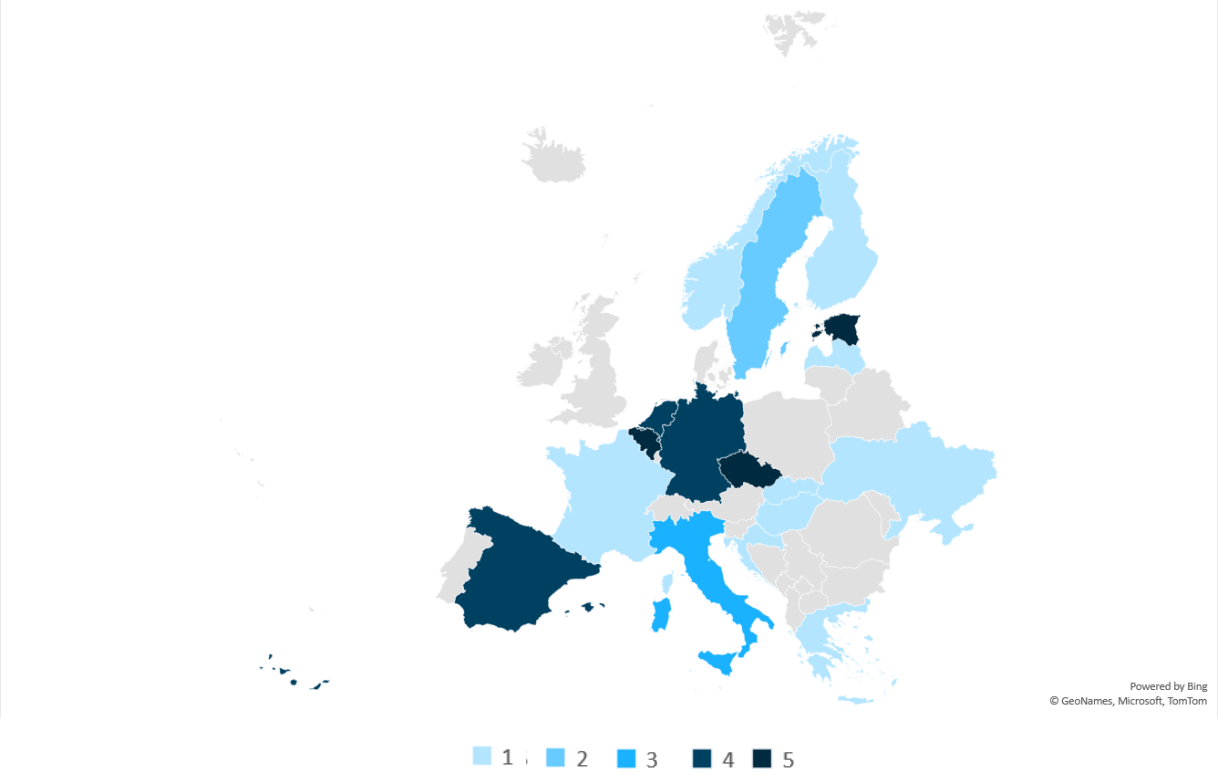


Figure 6 Number of Survey responses by European countries represented in the survey.

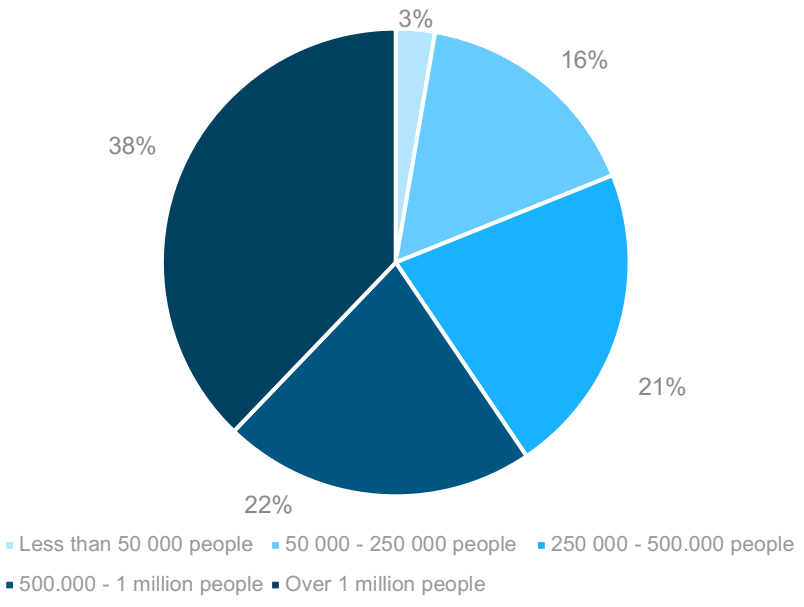


Figure 7 Population size ranges of cities and regions represented in the survey.

Status of EV and charging infrastructure deployment

Both groups of respondents were asked to assess at what level of EV deployment their cities or regions were currently at. With one exception, all respondents from local and regional governments reported some advancement in EV and charging infrastructure deployment in their respective jurisdictions. Although at one end, more than a third of respondents (33%) indicated their cities were “starting up” with EV uptake, more advanced categories, that is “average,” “scale up” and “pioneer in Europe/advanced”, came up with 21%, each.

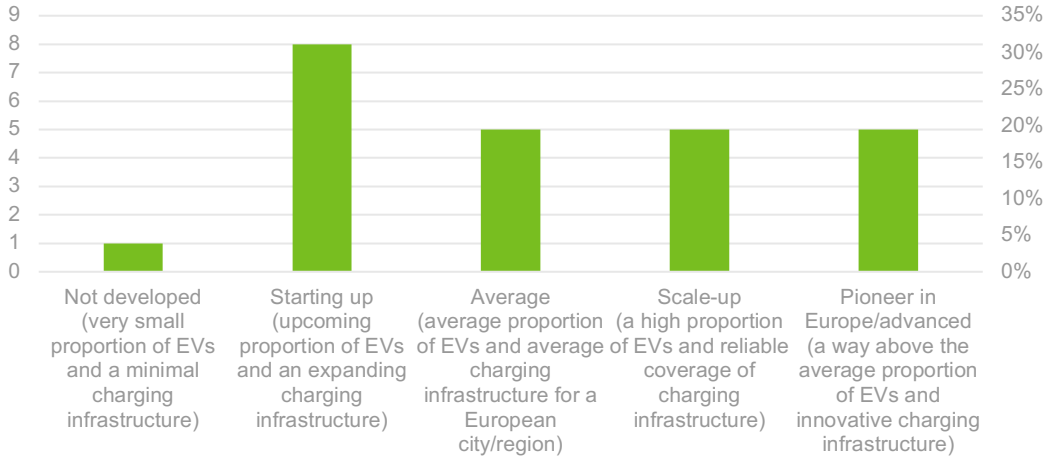


Figure 8 City and region government officials' perception on EV deployment and charging infrastructure. in their cities or regions

Regarding representatives of TSO and DSO’s: almost half of the respondents claimed EV deployment is just “starting up,” followed by 25% who perceived deployment as “average”. Only two respondents (5%) each reported “high” and “above average” deployment in their respective geographic areas of operation. Perception from both stakeholder groups seems to suggest that despite a non-negligible group of cities and regions represented in the survey having reached or are in the process of reaching massive EV adoption, for most cities and regions in Europe,

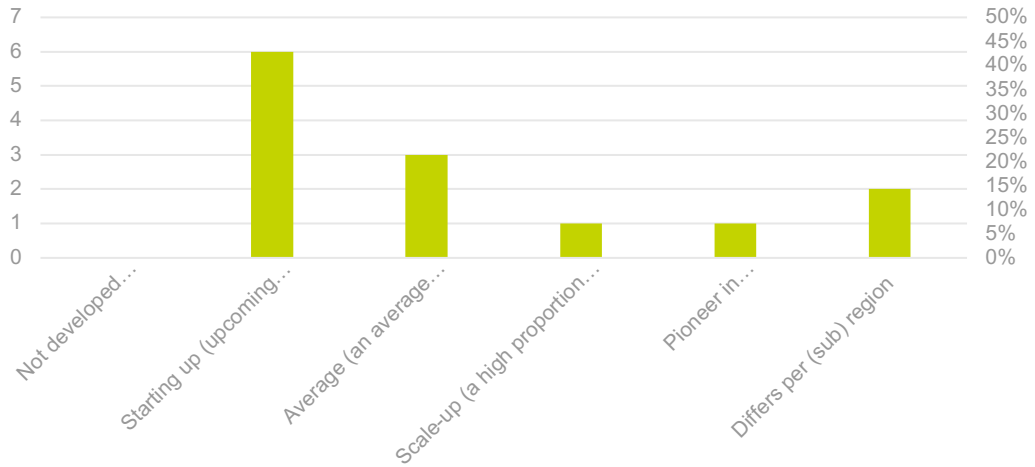


Figure 9 DSOs and TSOs' perception on EV deployment and charging infrastructure in their cities and regions.

Local and regional governments' plans and priorities on public charging infrastructure deployment

Regarding plans and strategies for wide spreading public charging infrastructure, most public authority officials indicated that their cities and regions had specific plans and strategies in place to roll out public charging infrastructure (54%) and/or included as part of broader mobility or decarbonization strategies such as Sustainable Urban Mobility Plans (SUMPs) and energy transition plans (75%). Some of the respondents who replied, "not sure," clarified to be, in fact, currently preparing the first versions or updates of plans and strategies concerning EV and charging infrastructure deployment.

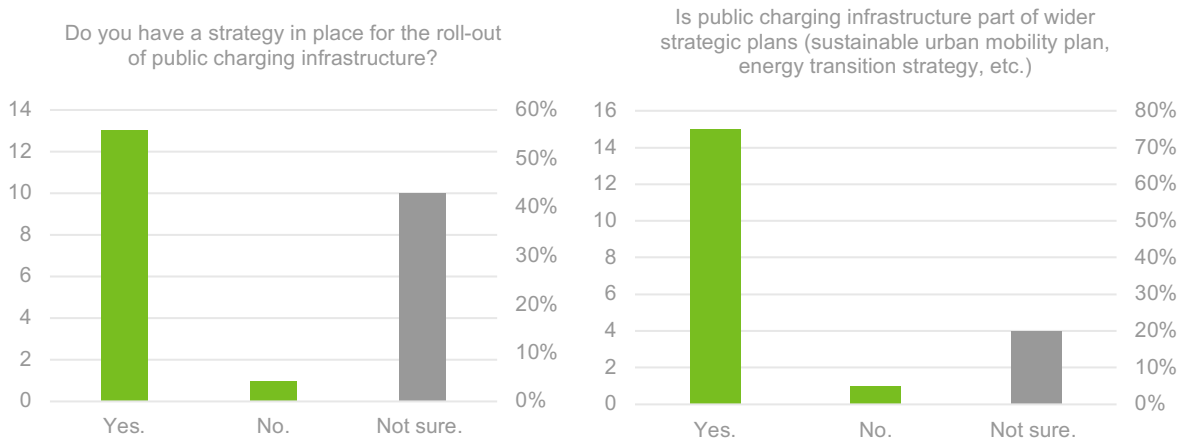


Figure 10 Government officials' responses regarding to the existing plans or strategies for public charging deployment and its integration with broader plans.

Diving into the priorities of current plans, strategies, and actions, representatives from local and regional authorities ranked "roll out of public charging stations" and "getting an area-wide coverage" throughout the city came as first and third most mentioned topics (see figure 11, last column). Respondents further indicated that efforts should also be made, or even focused, on increasing off-street rather than on-street (curb side) charging in common but privately owned facilities such as apartment buildings and offices to ensure widespread and convenient access. This is especially relevant in compact-dense areas where road space is scarce and where public space could be better allocated for other activities.

"Create interoperable charging infrastructure" and "Integrate EVs into the wider mobility solution" ended up tied for second place. For the former, it can be inferred that beyond physical access, there is a need to ensure standardisation and communication across different vehicles, connectors, charging stations, and software, regardless of the product or service provider. As for the latter, and based on information provided through open-ended questions, it seems that rather than spearheading public charging infrastructure indiscriminately, public authorities prefer to focus their efforts on areas with the most significant social and environmental impact where they can, for instance, encourage the replacement of fleets of taxis and delivery vans to reduce CO2 emissions and provide the conditions for EVs to be integrated into mobility hubs, such as airports, and park and ride facilities around trains stations to boost multi and intermodality.

Noticeably, "increase revenues for your city/region (through charging fees)" are ranked as the lowest priority for city officials. Although a city like Oslo has an interesting public/private partnership model with a 50%/50% split revenue model for public chargers.

	Not developed (very small proportion of EVs and a minimal charging infrastructure)	Starting up (upcoming proportion of EVs and an expanding charging infrastructure)	Average (average proportion of EVs and average charging infrastructure for a European city/region)	Scale-up (a high proportion of EVs and reliable coverage of charging infrastructure)	Pioneer in Europe/advanced (a way above the average proportion of EVs and innovative charging infrastructure)	TOTAL
Roll out public charging stations throughout the city to increase EV usage	1	7	3	5	4	**20**
Getting an area-wide general charging station coverage	1	6	2	2	3	**14**
Tap into private sector capital to roll out public charging points	0	5	1	2	1	9
Integrate EVs into the wider mobility solution	0	4	5	2	4	**15**
Increase revenues for your city/region (through charging fees)	0	0	0	1	1	2
Increase the amount of on-street public charging	0	4	1	4	3	**12**
Reduce the amount of on-street public charging	0	1	2	1	0	5
Investigate the use of electric vehicles plugged into public charging to stock renewable energy and balance the grid	0	1	2	0	4	7
Create an interoperable charging infrastructure	1	4	3	5	3	**16**
Other	0	2	1	2	1	6

Figure 11 Cities and regions public charging infrastructure priorities by stage of EV deployment

We mapped the priorities of cities regarding public charging infrastructure according to their stage of EV deployment. What stands out most about this is that cities and regions in a start-up phase logically seem to have more focus on ensuring a creating a well spread charging network. Cities and regions that are scaling up have a greater focus on interoperability.

Regarding the types of rendering processes used by cities and regions for public charging open tendering came by far as the most common procedure (41%). Restrictive/selective (8%), negotiated (5%), and open market (3%) tendering were also mentioned.[5]

[5] Explainer: 1) Open tendering: competitive tendering open to all 2) Restricted/selective tendering: invitation to suppliers to procure, not open to all. 3) Negotiated tendering: inviting a single supplier to deliver the work. 4) Open Market Model: several providers of charging stations may be active in the same city/area. This means that in principle an open tender from market parties applies to every charging station.

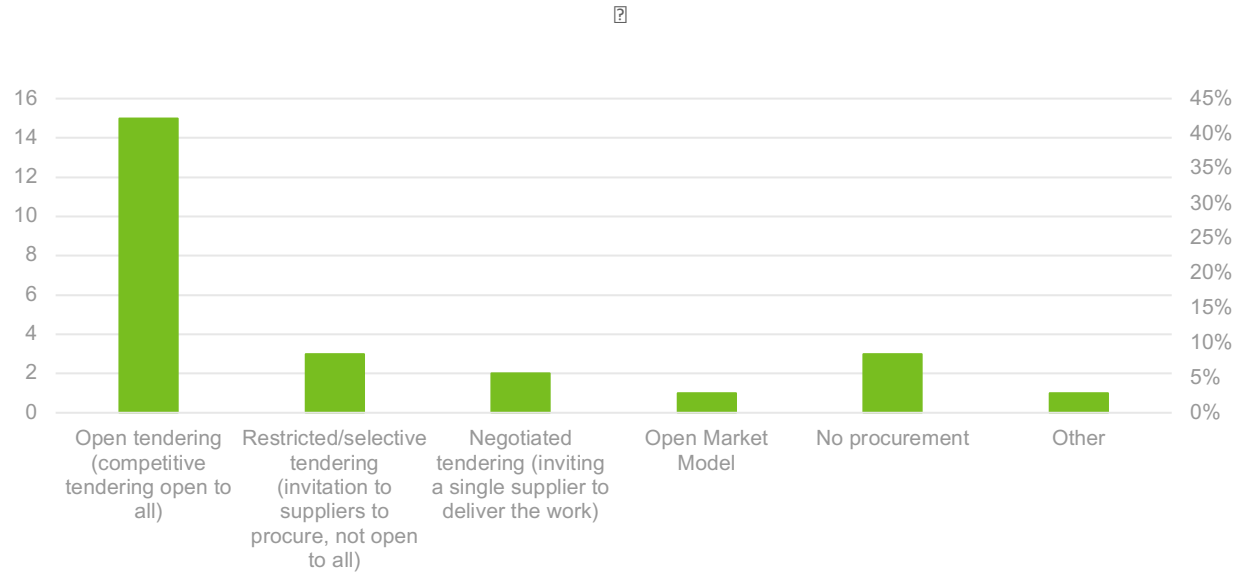


Figure 12 Local and regional officials' responses to the question "What procurement processes does your local or regional government use for public charging?"

The problem with grid congestion and the case for smart charging and V2G

Most stakeholders, both from local and regional governments and the energy operators, considered grid congestion an eminent problem ahead of EV massive uptake. More than two-thirds of government representatives surveyed deemed grid congestion as a current "issue" (58%) and "major issue" (13%) in their respective cities and region.

In comparison, DSOs and TSOs respondents regarded grid congestion as not acute, but still a serious issue. While 3 out of 10 respondents did not consider it a problem, 6 out of 10, deemed grid congestion as somewhat problematic.

Figure 1 Governments officials' perceptions on the question "Do you assume that electricity grid congestion will become a larger problem in your city/area in the upcoming years.

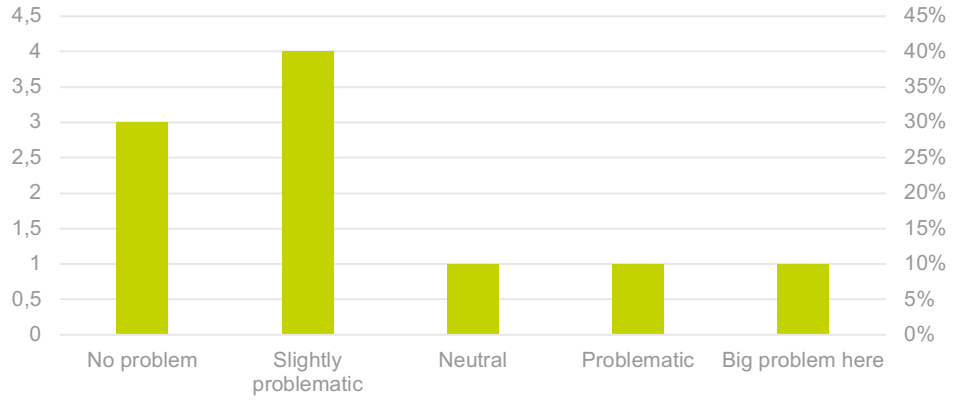


Figure 14 DSOs and TSOs' perceptions on the question "Do you assume that electricity grid congestion will become a larger problem in your city/area in the upcoming years.

Regarding grid congestion, the issue seems not to be whether it is a problem or not at this moment, but about when it will be. While about a fourth of both government officials (25%) and TSOs and DSOs (38%) considered grid congestion to become a major problem in the medium term, 5-10 years, a slightly larger proportion of the respondents, that is 32% and 38% of respondents, respectively, anticipated grid congestion to become a problem much sooner in their respective jurisdictional areas.

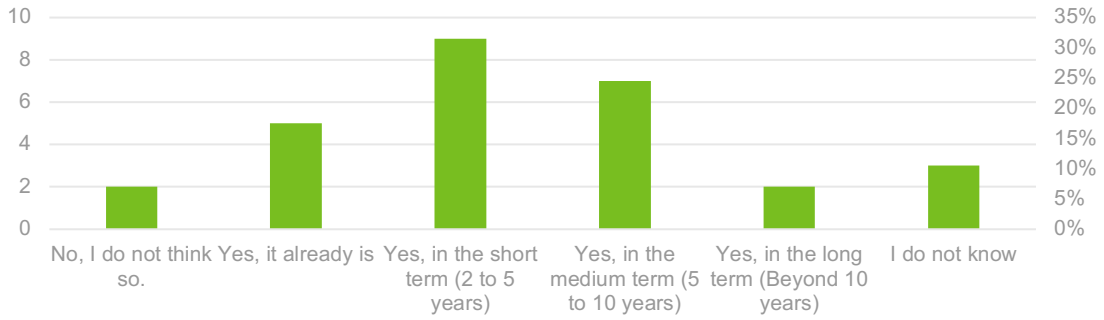


Figure 15 Governments officials' subjective prognoses on the question "do you assume that electricity grid congestion will become a larger problem in your city/area in the upcoming years?"

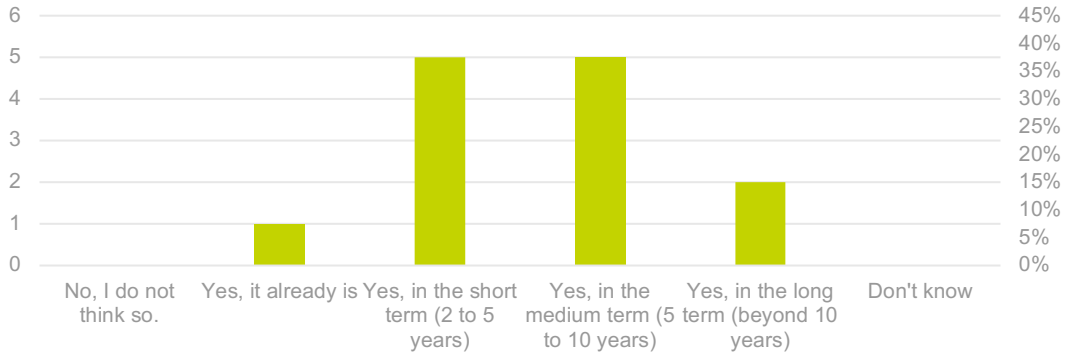


Figure 16 DSOs and TSOs' subjective prognoses on the question "do you assume that electricity grid congestion will become a larger problem in your city/area in the upcoming years?"

There is consensus about the electricity grid situation will become a problem at a certain point in time. Both stakeholders' groups declared to consider either smart charging (13% of the city and regional government officials and 31% of DSOs and TSOs respondents) or smart charging plus V2G (38% and 31% of both groups, respectively) it seems they are not implemented yet. At the time of this survey's closing in mid-March 2023, 4 out of 24 city and regional government officials (17%) and 4 out of 13 (15%) DSOs and TSOs respondents declared to have already implemented smart charging in their respective jurisdictions. As for intelligent and V2G infrastructure, numbers dropped to 1 out of 22 (8%) and 1 out of 13 (8%), respectively.

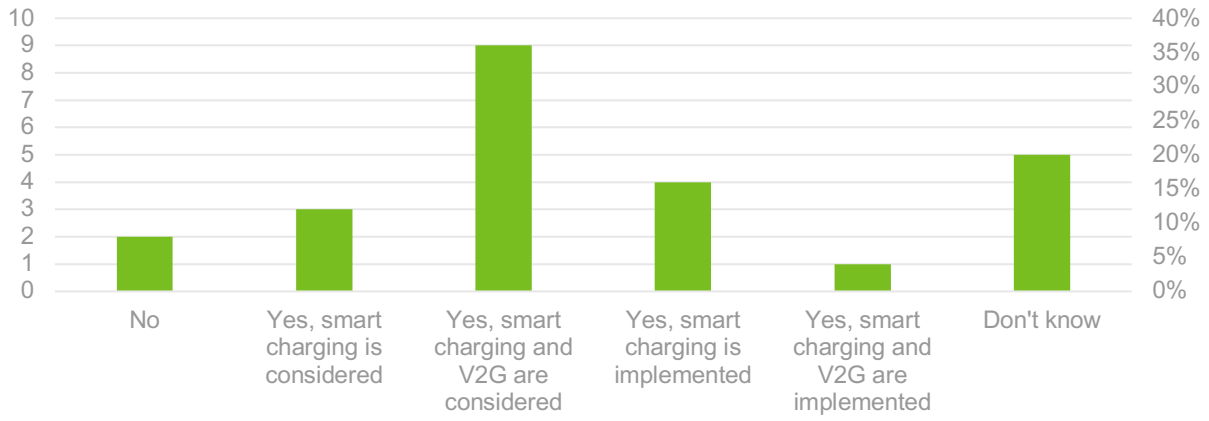


Figure 17 Government officials' responses on the question "Are you using or considering smart charging or Vehicle-to-Grid (V2G) to balance tensions on the grid?"*

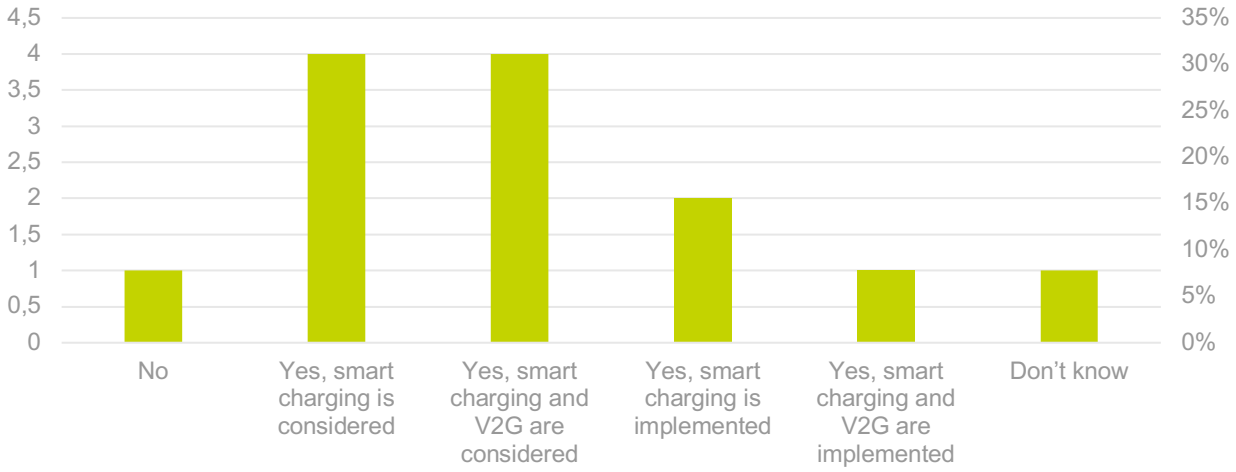


Figure 18 DSOs and TSOs responses on the question "Are you using or considering smart charging or Vehicle-to-Grid (V2G) to balance tensions on the grid?"*

The most important conclusion is that a large majority of respondents believe that grid congestion is not an issue yet in their cities or regions, but they do foresee that it will be in the future. In addition, the implementation of smart charging and optional V2G will be important to postpone or prevent the expected grid congestion. But there is a lack

of knowledge about how to properly implement smart charging and optional V2G technology. This became also evident from various interviews.

Knowledge and information needs

As illustrated in the tables below, in general local public authorities' awareness of V2G and smart charging differ greatly depending on the EV maturity of the city or region they work in.
Many respondents from cities and regions "Starting up" with EV deployment claimed to have knowledge and information gaps across all the topics. In this group of cities ranked the highest, "Predictions for EV charging demand per suburb," closely followed by "Defining the strategy on how to let grow the EV charging network,".

Some topics ranked very highly as knowledge and information needs regardless of cities' different levels of EV deployment. For example, "Information on hardware requirements for Vehicle-to-Grid charging infrastructure" was ranked the most significant gap overall, followed by "information on software requirements for vehicle-to-Grid charging infrastructure" and "Predictions for grid constraints," tied at second place. This backs up the generalized concern on grid constraints identified above and seems to suggest that although V2G is still a very new and unknown topic for local and regional officials, it is already regarded as a potential solution to address current or future problems with grid capacity.

Similar to the results from government officials, TSOs and DSOs also ranked information on both hardware and software requirements for V2G as the first and second most mentioned gaps, closely followed by "predictions for grid constraints" in third place, with no significant differences among claimed stages of EV deployment.

	Not developed (very small proportion of EVs and a minimal charging infrastructure)	Starting up (upcoming proportion of EVs and an expanding charging infrastructure)	Average (average proportion of EVs and average charging infrastructure for a European city/region)	Scale-up (a high proportion of EVs and reliable coverage of charging infrastructure)	Pioneer in Europe/advanced (a way above the average proportion of EVs and innovative charging infrastructure)	TOTAL
Location planning for EV charging stations	1	3	0	0	0	4
Predictions for EV charging demand per suburb	0	6	1	0	0	7
Predictions for grid constraints	0	4	2	3	1	10
Digital tooling for this subject (locations planning, grid constraints, etc.)	0	1	1	1	1	4
Validated tender procedures for EV smart charging infrastructure	1	3	1	0	0	4
Validated tender procedures for Vehicle-to-Grid charging infrastructure	1	3	1	1	1	6
Information on different market models to consider in Tenders.	1	4	1	0	0	5
Information on hardware requirements for EV smart charging infrastructure	1	3	1	0	0	4
Information on software requirements for EV smart charging infrastructure	1	4	1	0	0	5
Information on hardware requirements for Vehicle-to-Grid charging infrastructure	1	5	2	3	2	12
Information on software requirements for Vehicle-to-Grid charging infrastructure	1	6	1	1	2	9
Defining the strategy on how to let grow the EV charging network	1	5	2	0	0	7
Other	0	0	0	3	1	4

Figure 19 Governments officials identified knowledge and information gaps by cities and regions' state of EV deployment.

	Not Developed (very small proportion of EVs and a minimal charging infrastructure)	Starting up (upcoming proportion of EVs and an expanding charging infrastructure)	Average (average proportion of EVs and charging infrastructure for a European city/region)	Scale-up (high proportion of EVs and reliable coverage of charging Infra-structure)	Pioneer in Europe/advanced (a way above the average proportion of EVs and innovative charging infrastructure)	Differs per region	TOTAL
Location planning for EV charging stations	1		1	1		1	4
Predictions for EV charging demand per suburb	1	2	2	1			6
Predictions for grid constraints	1		1	1		1	4
Digital tooling for this subject (locations planning, grid constraints, etc.).		1	1	1		1	4
Validated tender procedures for EV smart charging infrastructure		2					2
Validated tender procedures for Vehicle-to-Grid charging infrastructure		2					2
Information on different market models to consider in Tenders.		1	1			1	3
Information on hardware requirements for EV smart charging infrastructure			2				2
Information on software requirements for EV smart charging infrastructure		1	2				3
Information on hardware requirements for Vehicle-to-Grid charging infrastructure		4	2	1		1	8
Information on software requirements for Vehicle-to-Grid charging infrastructure		4	1	1		1	7
Defining the strategy on how to let grow the EV charging network		1	2			2	5

Figure 20 DSOs and TSOs' identified knowledge and information gaps by cities and regions' state of EV deployment.

3.2.2 Interview outcomes

Interview outcomes cities and regions – clustered

To understand the challenges in the implementation of smart charging and V2G, it is essential to hear the perspective of European cities and regions. We collected information through nine interviews with professionals working in European municipal and regional public administrations. These findings are clustered into five thematical categories.

The interviewees were representatives from the cities of Arnhem (NL), Leuven (BE), Madrid (ES) - the city council and EMT Madrid, Barcelona (ES), Stockholm (SE), Tallinn (EE), Oslo (NO) and the Province of Utrecht (NL). More information can be found in appendix 4.

Theme 1: Public passenger-vehicle charging infrastructure deployment and strategies - what are the visions?

- The **municipality of Arnhem's** guiding strategy for its public charging network is to increase the number of points ahead of the demand in order to ease users' transition to electromobility. They just signed a new concession to go from 600 to 700 public charging points. In addition, they are applying different strategies for public charging deployment according to the neighbourhoods. This includes street lamp post charging in new developments, charging plazas and charging in parking lots in the old town, on-demand charging point installation and a stronger focus on consultations in the north of Arnhem (low coverage). Finally, the municipality has an overarching map of desired charging spots in the city and they work with Vattenfall (CPO) on the placement of charging points.

- The **Barcelona City Council** is focusing on keeping public charging under the control of the municipality. All points are operated by BSM, a municipal owned company (see Box A). They are installing chargers in publicly accessible publicly owned parking lots, fast chargers (only) in the public space and chargers for motorbikes. The private sector has little to no role in Barcelona's public charging infrastructure. However, they are thinking of creating a mixed company (public-private) to grow the number of chargers but with the municipality keeping the decision-making power. They are also looking to work with a private CPO to deploy public chargers for electric taxis.

- Our interviewee from the **Madrid City Council** summed up the city's strategy in a key phrase" "*We (the Council) do not talk about a public network of charging stations because we think this is not a public service. We just want to foster the public access to charging*". Just like Barcelona, Madrid only puts fast chargers in the public space and there are only a few. Their vision is that public charging is a safety net, but most if not all should be done at home and at work (Box A). The council provides chargers to private stakeholders to install them on private land that is publicly accessible. Currently, they are doing a concession to have more on-street fast chargers and they have upcoming plans to create hubs/plazas of fast chargers in cooperation with private stakeholders like ride-hailing companies. The transport operator **EMT Madrid**, the municipal transport company, is responsible for public charging in public parking lots and they have their own app to pay for the charging. Their latest project is "Canalejas 360" which is an electric mobility hub with 12 chargers and houses the most powerful urban EV charger in Spain (400 kW) part of the Madrid 360 Sustainable Mobility Plan.

- The **municipality of Leuven** is also putting the priority on home charging and limiting the amount of charging in its public space. In the past, charging points were installed all over the city including on the footpath – now they do it in a more strategic way using demand and data-driven approaches. If residents demand on-street charging, they need to have a fully electric vehicle and no private parking. There is also a focus on creating "Shared red Mobility Hubs" that encourage multimodality and include shared EVs and charging stations. The

goal in the near future would be to have only fast and smart charging to limit the space charging takes in the city. The municipality is currently working with the Flemish government on a tender (Box C).

- The **City of Stockholm** currently has over 4 000 public charging points. Its on-street charging is managed through access right agreements with private companies for a duration of 10 years. Currently, there are 7 operators in Stockholm. The municipality has mapped the entire inner-city centre for potential locations for charging points and they do on-demand charging points. Public off-street charging is done by Stockholm Parkering, which is 100% owned by the city, in its garages and in outside off-street locations. They are equipping their new garages with 100% charging on all spots (from 50 to 800 places in a parking lot), with around 1 garage being built a year, and they are adding charging to their existing garages. The municipality also has real estate and housing companies that add, amongst others, public charging stations. In the outskirts of the city, street light post charging is being added because the city owns the grid and the lamp posts. For private charging, extensive information campaigns, events and workshops are organised by the municipality to encourage home charging. The municipality of Stockholm does not want charging to take up too much public space nor does it want it to increase car use which inhibits multimodal streets.

- The City of **Tallinn** is about to publish its first charging infrastructure strategy that will have an enforcement component– it is waiting for political approval. Public charging is operated by the private sector as well as a state company (Enefit). Prior to this strategy, the biggest plan was the national wide ELMO program launched in 2011. It enabled the kickstart of the country's charging station network and it was financed by a CO2 emission trade agreement between the Estonian government and Mitsubishi Corporation under the Kyoto Protocol. However, today, EV ownership is still low and few incentives are in place.

- In the Province of **Utrecht**, a multi-year infrastructure program for energy and climate is in place and will accelerate the development of the network and prioritise demand.

Box A: Preserving the public space for public uses, keeping public charging under the power of the municipality – the case of Barcelona and Madrid (Spain)

Interviewing the City Councils of Madrid and Barcelona highlighted a unique conceptualisation of the public space and the role of public charging. In both cities, on-street public charging is always fast charging and their operation, financing and maintenance are ensured by public bodies. Although this is slowly changing with the increasing role of the private sector (taxis, small concessions, etc.), it was clear from the interviews that the public space was perceived as being an affair of the public sector, not of private CPOs and operators.

- In Barcelona, the BSM (Barcelona de Serveis Municipals) - a municipal public company - is in charge, amongst others, of the operation and maintenance of charging points both on-street and in publicly owned and publicly accessible parking lots. The private sector has little to no role in the public charging infrastructure.
- In Madrid, the strategy has been to give charging points to private stakeholders so they can install charging points in a publicly accessible manner (e.g., petrol stations, hotels, etc.). The city is currently doing a concession to further include the private sector into public charging: it just launched a call for tenders for 36 fast charging points in the city (≥ 50 kW). EMT Madrid – the public transport operator - is in charge of the charging points in public parking lots.

In both cities, public charging on-street charging is understood as only a "safety net" for EV users to reduce anxiety range and improve trust in using electromobility. For them, the core of charging should happen in private parking, homes and at the office, not in the public space. It is clear that both cities have a similar vision of the role

of public charging, but Madrid is very slowly letting in the private sector to use its public space to ramp up charging.

More information:

Barcelona: Electric vehicle | Mobility | Barcelona City Council

Madrid: Movilidad eléctrica - Puntos de carga para vehículo eléctrico de acceso público - Ayuntamiento de Madrid

Theme 2: Smart charging and V2G: what has been tested in the cities and regions?

- In **Arnhem**, they are testing smart charging and V2G to store locally produced renewable energy and alleviate grid congestion. Smart charging pilots have happened as part of Interreg CleanMobilEnergy project - see Box B. However, V2G is seen as a solution for the future. There are some early applications that can be conceptualised, according to our interviewee, including using V2G in newly built self-sufficient neighbourhoods.

- There are no V2G pilots in **Barcelona**. However, the City Council are already interested in the potential of smart charging. They are participating in a Horizon 2020 project eCharge4Drivers where they are testing the user acceptability of smart charging, potential incentives and schemes to enable their uptake.

- For **Madrid,** smart charging and V2G is currently not a priority for public charging. Incentives for smart charging are destined for home charging instead. **EMT Madrid** is testing fast charging and new technologies in its public parking lots. However, most of their innovations are in their electric bus depots.

- The municipality of **Leuven** is very keen on smart charging, linking renewable energy production and EV charging. KU Leuven is working with an energy cooperative to put solar power on all public buildings and their own buildings. One of the uses of this energy will be shared e-mobility and potentially using the batteries to stock the energy produced.

- In Sweden, V2G has been tested with a pilot in the municipality of Kungsbacka (close to Gothenburg). Within **Stockholm**, pilots of V2G have been hard to implement due to low interest to do a trial and the city has had a hard time bringing together the required stakeholders (Box B).

- In the City of **Oslo**, there is an increased interest in V2G technology for housing cooperatives and shopping malls.

Box B: Testing new technologies first requires bringing all the relevant stakeholders to the decision-making table – the case of the municipalities of Stockholm and Arnhem

The city of **Stockholm** has looked into the potential of smart charging and V2G, notably through the EU-funded MEISTER project. They tried to control peaks on the grid through on-street public chargers and test V2G but they were not able to get all the actors on board to test the new technologies with them. Another key barrier is the low number of vehicles that can currently do V2G. The city would have to do a special procurement with relevant OEMs to do demos. They will keep a close eye on the work of Gothenburg in SCALE to see if there are any results that can be replicated.

The city of **Arnhem** has tested smart charging through the Interreg CleanMobilEnergy project. They connected locally produced renewable energy to charging points and plazas in the city through an Energy Management System. The municipality is currently working with the CPO to ensure they can legally buy and use the renewable

energy for the charging points. Our interviewee shared the challenges of working with all the needed actors to make smart charging a reality in Arnhem, but they are getting there.

Link: CleanMobilEnergy - Clean Mobility and Energy for Cities | Interreg NWE (nweurope.eu)

Theme 3: Grid constraints and energy management: Is it already a challenge and what are the measures taken to alleviate it?

- The municipality of **Arnhem** is experiencing issues with grid congestion. They find it challenging to get high-capacity connections to the grid which hinders public charging infrastructure expansion. The grid is already saturated and there are long waiting times. For these reasons, Arnhem is focusing on charging plazas paired with smart charging and renewable energy.

- For the **Barcelona City Council**, managing heavy connections to the grid is a challenge to upscale its network and grid congestion is foreseen as a growing issue.

- The **Madrid City Council** is working with the DSO to draw potential locations for public fast charging points where the network is not saturated. This is particularly a concern for the e-mobility hubs of fast charging they are currently thinking of creating.

- In **Stockholm,** the energy grid is an issue and they are looking to shave the peak. However, smart charging and V2G still face some jurisdictional challenges.

- The City of **Tallinn** have a hard time getting connections to the grid: for every station they install, they need to request a connection to the DSO and pay for it, which takes time.

- In the **Province of Utrecht**, the grid limitations at the local level are leading to struggles with peak energy demand. National and regional grids are good, but the local grid faces challenges. The province is struggling with peaks and increased energy costs. This is similar to the situation reported in **Oslo**.

Theme 4: Multi-level public governance: what are examples of municipality-region cooperation?

- The municipality of **Arnhem** works closely with other cities in the region (including Nijmegen and Apeldoorn), the province of Gelderland, as well as the Green Metropolitan region Arnhem-Nijmegen to discuss ongoing affairs and common challenges linked to their charging infrastructures. At the national level, the NLA (national agenda for charging infrastructure) is divided in multiple parts of the country: Arnhem is the eastern part (provinces Gelderland + Overijssel). These are active networks and working groups that support Arnhem to cooperate, learn and share best practices with different levels of governance in the Netherlands.

- The City of **Leuven's** tender process for public charging infrastructure is currently undertaken at the Flanders level with all cities of the province except 3 cities (see Box C).

Box C: Going from the local to the regional: testing new public charging deployment tenders- the case of the city of Leuven (Belgium)

Leuven is taking part in the pooled Flanders' (Flemish Government) public charging concession with CPOs Engie and Total Energy who will install the points between 2023-2024. The contract gives both companies an exclusivity of two years to install points through a demand and data-driven approach, and they will have to maintain the

infrastructure for 12 years. The goal of the Flemish Government is to create momentum and highly boost the number of public charging points. Previously, the Flanders Government worked with the grid operator (Fluvius) to deploy public charging. Currently, 8 out of 10 public charging points in Belgium are in Flanders.

The City of Leuven is looking forward to assessing this type of contract, but is still exploring the possibility of clustering with other cities or doing a tender alone next time they do a concession. Amongst others, they hope to guarantee more revenues to the city from the concession of public space and have more bargaining power to decide the location of the points. However, a pooled concession has advantages for small and medium sized cities that have limited capacity in their mobility department – which includes Leuven.

Further information:

Charging points for electric cars | City of Leuven

Public charging points for electric vehicles | Vlaanderen.be

Theme 5: Public and private sector involvement: what role are private stakeholders given?

- The municipality of **Arnhem** works with private CPOs - Allego and Vattenfall - for the financing, operation and maintenance of public charging infrastructure through 8 to 10-year contracts.

- For the City Council of **Barcelona**, if a private operator is interested to install charging points, their main opportunity is to work with private garages. The public space is perceived as being for public use only and should be managed by public entities. The City Council is thinking of doing an exception for taxis and working with a private CPO to accommodate their charging needs. Previously, they had a platform for private stakeholders to meet: Life Platform. It was created in 2010 to create momentum for e-mobility, but this should no longer be led by public stakeholders according to the municipality.

- The **Madrid City Council** has a similar approach to Barcelona, but gives more access to the private sector. One of the reasons for their increased turn towards the private sector in public charging is due to the unpredictability and low use of some charging points.

- The municipality of **Leuven** works with CPOs' Total Energy and Engie in the Flanders tender (see Box C).

- Our interviewee in **Stockholm** stated in a humorous way "*the municipality does not take care of fuelling stations, why should it so for charging stations? We think it is something that the market should do*". This quote sums up their stance on delegating the charging infrastructure to the private sector and the market. The role of the municipality is to lead at a policy and strategic level, but not to take care of the day-to-day operation and maintenance of the public points.

- The City of **Tallinn** hopes to work more closely with the private sector through public-private partnerships to boost its charging infrastructure and install different charging systems according to the neighbourhoods' needs (fast charging, slow charging, etc.). They have started to map the potential locations and started discussions with private stakeholders.

- In **Oslo,** a subsidy scheme for private smart charging infrastructure exists. Under the scheme, users pay for the hardware, and subsidies cover 30% - 50% of the infrastructure costs. Additionally, valuable advice and guidance are provided to applicants throughout the process. There are many DC fast chargers in Oslo, with an interesting 50/50 split profit model between the charging operator and the city.

Interview outcomes DSOs and TSOs - clustered

The most important information from the interviews with relevant professionals from the DSOs and TSOs is categorized below. More detailed information can be found in appendix 9.

1. **Grid capacity and management:**
   - Enedis (DSO): Smart charging can help avoid 30% of grid reinforcement by rescheduling EV charging to off-peak hours, coupled with energy efficiency of buildings and switching from electric heating to heat pumps.
   - Sadales tīkls (DSO): Grid automation and moving to ADMS are priorities to prepare for increasing demand; peak loads and net metering system are key concerns.
   - CEZ Distribuce (DSO): Ongoing integration of new lines, distribution stations, and renewable electricity generation facilities
   - PREdistribuce (DSO): Challenges in construction permits and infrastructure for new substations in Prague.
   - Tennet (TSO): Congestion problems are national and local, with local congestion being more significant. The Netherlands requires between 3 and 1500 MW of control capacity. Bidirectional capability of discharging with 7 kW means that only ~215.000 electric vehicles (batteries) are needed at the maximum moment. Out of 8 million vehicles in the Netherlands (< 3%).
   - TransnetBW (TSO): Grid expansion is a major challenge, mainly driven by renewable energy.

2. **Regulation and incentives:**
   - Enedis (DSO): Government incentives and taxes can influence behaviour, like bus operators asking for more power than needed; suggests making price differences for capacity packages more significant to encourage smart charging.
   - Sadales tīkls (DSO): Regulatory changes drive workload and process changes; government incentives can lead to customer disappointment when grid connection is not possible.
   - CEZ Distribuce (DSO): Working on standardization, possible future mandate for fast chargers to communicate load to the grid.
   - PREdistribuce (DSO): Discussions with regulatory bodies about requirements for chargers
   - Tennet (TSO): Market models and roles (BSP and CSP) are the biggest challenge in integrating EVs and V2G services.
   - TransnetBW (TSO): TSOs face tensions between regulated schemes and potential for new market approaches. Cooperation among market players is vital for a successful energy transition.

3. **Smart meters and tariffs:**
   - Enedis (DSO): Smart meters (Linky) could be used in conjunction with Charge Points for better energy management.
   - CEZ Distribuce (DSO): Smart meters to be implemented in the future; change of tariffs planned for electrification.
   - PREdistribuce (DSO): Smart meter rollout planned from next year until 2027.
   - Sadales tīkls (DSO): All customers have smart meters, allowing them to choose between dynamic energy tariffs or fixed tariffs; Time of Use tariff introduced as an option.
   - TransnetBW (TSO): Privacy and security regulations, along with cultural factors, hinder the smart meter rollout in Germany. Data sharing remains a challenge.

4. **Customer connections and expectations:**
   - Enedis (DSO): Decision making for EV charging in apartment buildings is challenging, we are offering a DSO solution to invest upfront.
   - CEZ Distribuce (DSO): Household connections not prepared for 3-phase 11 kW chargers; working on solutions for increased EV adoption.

- PREdistribuce (DSO): Preparing for increased EV adoption; challenges with construction permits in Prague
- Sadales tīkls (DSO): Customers can be disappointed when they can't connect their PV systems, even though the grid is nearing capacity.
- Tennet (TSO): Convenience is more important than financial benefits for EV users. Smart charging and V2G services should be simple, easy to use, and scalable.

5. **Integration and planning:**
   - CEZ Distribuce (DSO): Cooperation at the national level with DSO/TSOs; cities and regions not yet involved in planning for charging infrastructure.
   - PREdistribuce (DSO): Pilot projects and collaboration with other DSOs, TSOs, and regulatory bodies for integrated planning; involvement in National Action Plan for Smart Grids
   - Tennet (TSO): Grid adaptation planning takes place in three time periods: next week, upcoming decade, and after the next decade. The relationship between DSOs is good but has its challenges.
   - TransnetBW (TSO): Uncertainty is increasing, making integrated planning more challenging. Cooperation between TSOs and DSOs is crucial. Data exchange is key as decentralized production and consumption grow.

6. **Smart charging and V2G:**
   - CEZ Distribuce (DSO): Piloting different smart charging platforms; focus on building more chargers; limited knowledge about V2G technology.
   - PREdistribuce (DSO): Smart charging and V2G pilot projects; Skoda plans for AC V2G pushed to 2025.
   - Enedis (DSO): Alignment of various grid components is a challenge due to increasing renewable energy sources.
   - Sadales tīkls (DSO): Integrated planning that combines future situations and maintenance needs is challenging; prognoses are a ‘guess game’ and annual targets are reactive.
   - Tennet (TSO): EV smart charging and V2G services should be seen as opportunities rather than problems. They can help balance the grid and provide financial benefits for EV drivers.
   - TransnetBW (TSO): Investment in smart charging technology can reduce the need for grid expansion. TransnetBW is working on various smart charging and V2G projects, such as Mobility-4-Grid and BANULA.

7. **Learning from frontrunners:**
   - CEZ Distribuce (DSO): Collaboration with ElaadNL and learning from the Netherlands' experience.
   - PREdistribuce (DSO): Information exchange with EnBW, one of the biggest Charge Point operators in Germany
   - Sadales tīkls (DSO): Interested in learning from countries like the UK, Germany and the Netherlands on EVs, charging infrastructure, flexibility services, smart grid integration, and optimal network usage.
   - Both TSOs Tennet and TransnetBW emphasize the importance of cooperation, data exchange, and the development of new market models to address the challenges and opportunities associated with the mass uptake of EVs and the implementation of smart charging and V2G services.

3.2.3 Lessons from European best practices and Desk Research

Front running cities have already developed solutions and procedures to many needs and challenges laid out in this report including grid congestion, integration of new technologies such as V2G and smart charging and the scarce use of public space. This section can support cities and regions learn from best practices from both desk research and the interviewees. In addition, the report's main author being the City of Utrecht has led to the integration of the lived experience and knowledge of this city in this section.

Sharing lessons and experiences amongst (local) governments, grid operators (DSOs/TSOs), various (public/private) partnerships, companies and knowledge institutes may help accelerate the mobility and energy transition. And lessons can be learned from passed failures and mistakes. As a Greek DSO put it in an interview, with a smile, "We like to learn from others' mistakes".

City needs & challenges regarding smart charging & V2G from relevant online sources

City and regional needs and challenges regarding smart charging & V2G were identified and assessed using interviews, the two surveys, relevant online sources and the experience of the City of Utrecht. These can be clustered in four main topics:

1. **Procurement / Tendering:**
    a. Uniform standards for charging stations
    b. Cyber security
2. **Grid impact and smart charging specifications**
3. **Advanced integrated planning**
    a. Need for dynamic data exchange between city and grid operator
    b. Existing digital tools for EV Mobility and Energy network Planning.
4. **Innovation regarding future needs**
    a. Approach towards V2G
    b. Heavy duty charging

1. Procurement / Tendering:

The report "Uniform Standards for Charging Stations: From Policy to Realization" (NKL) highlights key considerations for implementing charging stations in cities. The main points include:

1. Uniform standards for charging stations to ensure a consistent degree of quality, safety, and user experience.
2. A clear policy framework to help facilitate the deployment of charging infrastructure and promote transparency, predictability, and efficiency.
3. Stakeholder collaboration through the cooperation of local governments, grid operators, charging station operators, and other stakeholders to successfully implement and manage a charging infrastructure.
4. Accessibility and usability of charging stations to ensure a positive experience for EV drivers.
5. Integration of charging infrastructure with urban planning should be considered with careful attention to manage its impact on public space, parking, and local regulations.
6. Innovation and sustainability, such as smart charging and V2G services, while also prioritizing the use of renewable energy sources for charging stations to support environmental and sustainability goals.

In summary, the report highlights the importance of uniform standards, a clear policy framework, stakeholder collaboration, accessibility, urban planning integration, and a focus on innovation and sustainability in the development of EV charging infrastructure.

1a. Uniform standards for charging stations

The "Standards for EV Smart Charging" report by ECOS and RAP adds unique insights into the procurement and tendering processes for local governments, complementing the existing knowledge on smart charging and V2G services. Key takeaways from this report include:

1. The importance of international standards to ensure the interoperability, safety, and efficiency of smart charging infrastructure. The report encourages local governments to consider these standards when defining requirements for procurement and tendering.
2. Procurement best practices includ defining clear technical requirements, ensuring environmental sustainability, and addressing potential barriers to entry for small and medium-sized enterprises (SMEs).
3. Tendering recommendations includethe need for a transparent and competitive tendering process that encourages innovation and cost-effectiveness achieved bysetting clear evaluation criteria, promoting dialogue with potential suppliers, and using a performance-based approach.
4. Policy recommendations to support the deployment of smart charging infrastructure include harmonising regulatory frameworks, fostering public-private partnerships, and facilitating access to funding and financing options.

In summary, the "Standards for EV Smart Charging" report offers valuable insights into the procurement and tendering processes for local governments, focusing on the importance of international standards, best practices, and policy recommendations. This information complements the existing knowledge on smart charging and V2G services, equipping European cities with a more comprehensive understanding of the necessary steps to successfully implement smart charging infrastructure.

The report "Recommendations for Public Authorities on: Procuring, Awarding Concessions, Licenses and/or Granting Support for Electric Recharging Infrastructure for Passenger Cars and Vans" (Sustainable Transport Forum) outlines several needs and challenges faced by European city officials in developing a future-proof charging infrastructure for electric vehicles. The following key points highlight these needs and challenges, along with the suggested solutions:

1. Need for clear legal and regulatory frameworks: City officials face the challenge of creating an environment that fosters competition and supports a well-functioning market. The report recommends establishing clear legal and regulatory frameworks for EV charging infrastructure to address this need.
2. Defining policy objectives and targets: Cities need to set clear objectives, targets, and timelines to guide the development of recharging infrastructure. By outlining both short and long-term goals, public authorities can effectively plan for a future-proof charging network.
3. Ensuring transparent and non-discriminatory procedures: City officials face the challenge of promoting fair competition among market participants. The report suggests adopting transparent, non-discriminatory, and competitive procurement and concession processes to address this need.
4. Promoting technical standards and interoperability: To facilitate the integration of smart charging and V2G services, cities need to ensure charging infrastructure adheres to common technical standards and is interoperable. This will enable seamless interactions between different systems and devices.
5. Coordinating grid connection and planning: Authorities must consider the impact of EV charging infrastructure on the grid and coordinate with grid operators to ensure efficient integration. This includes addressing grid capacity and reinforcement needs to prevent potential issues.
6. Adopting a user-centric approach: City officials need to prioritize user needs, accessibility, and convenience when developing charging infrastructure. This involves ensuring adequate coverage, easy payment methods, and real-time information availability for users.
7. Implementing performance monitoring and evaluation: Cities face the challenge of measuring the effectiveness of their EV charging policies and infrastructure deployment. Establishing performance monitoring and evaluation frameworks can help city officials identify areas of improvement and make informed decisions.

By addressing these needs and challenges and implementing the suggested solutions, European city officials can work towards creating a future-proof charging infrastructure that supports the widespread adoption of electric vehicles and the integration of smart charging and V2G services.

1b. Cybersecurity

The report, "Security requirements for procuring EV charging stations," (ElaadNL) focuses on the importance of addressing security concerns in electric vehicle (EV) charging stations and infrastructure. Key takeaways include:

1 Ensuring secure communication: Charging stations should have secure communication protocols to protect sensitive data and prevent unauthorized access or tampering.
2 Physical security: Robust design and materials should be used to prevent unauthorized access, vandalism, and theft, while also ensuring the safety of users and maintenance personnel.
3 Secure firmware and software updates: Charging stations should have a secure method for updating firmware and software to protect against security vulnerabilities and ensure compatibility with evolving standards.
4 Authentication and authorization: Charging stations must support secure authentication and authorization mechanisms to prevent unauthorized use and protect users' personal data.
5 Compliance with industry standards: Charging stations should adhere to relevant security standards and guidelines, such as ISO/IEC 15118 and IEC 61851.
6 Privacy and data protection: Personal data and usage information must be safeguarded in compliance with privacy regulations, such as GDPR, to maintain user trust and avoid potential legal issues.

In conclusion, integrated planning for smart charging and V2G services in cities should prioritize security aspects to ensure the safety and reliability of EV charging infrastructure and protect users' data and privacy.

2. Grid impact and smart charging specifications

The "Smart Charging: Steering the Charge, Driving the Change" book (in English, German and French, by ElaadNL) serves as a practical guide for European cities, addressing their needs and challenges in implementing smart charging and V2G services. Key aspects from the book that emphasize these needs and challenges include:

1. Municipal policy and roles: Cities need clear policies and guidelines for the development, implementation, and management of EV charging infrastructure. Local governments must take the lead in creating a supportive regulatory environment and coordinating with various stakeholders.
2. Implementation and management of charging infrastructure: One of the main challenges for cities is to establish a comprehensive plan for deploying and managing charging stations, considering factors such as location planning, installation, maintenance, and monitoring. Collaborating with grid operators and charging station operators is essential to overcome this challenge.
3. Communication and protocols: Cities must ensure seamless communication and compatibility between charging stations, energy management systems, and grid operators. The book provides guidance on adopting standardized communication protocols to streamline interactions and improve interoperability.
4. Cybersecurity: With the increasing reliance on digital networks, cities face the challenge of securing charging infrastructure against cyber threats. The book offers insights into established cybersecurity guidelines and best practices to ensure the safety and reliability of the network.
5. Programme of Requirements (PoR): The book provides a valuable resource for cities to develop a PoR, which helps convert charging objects into Smart Charging Ready infrastructure. The PoR includes technical specifications, communication protocols, and other requirements for the successful integration of smart charging technologies.

In conclusion, the book serves as a practical guide for European cities addressing their needs and challenges in implementing smart charging and V2G services. By providing insights into municipal roles, infrastructure management, communication protocols, cybersecurity, and a comprehensive Programme of Requirements, the book equips city officials with the knowledge and tools required for a successful transition tor smart charging infrastructure.

The resource Smart Charging Requirements (NAL) gives substance to one of the agreements that is being implemented within the NAL[6] Smart Charging working group and concerns the commitment that in the period up to 2030 only charging infrastructure will be rolled out that is Smart Charging Ready. The document can be seen as additional practical guide for European cities looking for what requirements to include in their tenders regarding smart charging. And offers the following relevant information:

1 Comprehensive technical requirements: The document provides an extensive list of technical requirements for smart charging infrastructure, covering aspects such as communication, demand response, and grid interaction. This information can serve as a valuable reference for European cities working on their own smart charging projects. Scalability and modularity: The SCR emphasise the importance of designing and implementing smart charging infrastructure that can easily scale and adapt to the growing needs of EV users. This helps ensure that cities can effectively respond to the increasing demand for EV charging services.
2 Interoperability and standardization: The document highlights the significance of adopting standardized communication protocols and technologies to facilitate seamless communication between charging stations, energy management systems, and grid operators. This enhances the overall interoperability and efficiency of the charging infrastructure.
3 Addressing grid constraints: The SCR underscore the need for cities to be aware of local grid constraints and work closely with grid operators to develop a strategy that addresses these limitations while implementing smart charging and V2G services.

So it focusses on technical requirements, scalability, interoperability, and it is addressing grid constraints.

3. Advanced integrated planning

3a. Need for dynamic data exchange between city and grid operator
Amsterdam's intensive collaboration with grid operator Liander is crucial for large scale e-mobility integration. Moving beyond biennial Electricity Thematic Studies, they engage in a continuous dynamic data exchange to enable better urban planning and optimized transformer station locations. This cooperation highlights the necessity for cities and grid operators to work closely together and maintain ongoing data sharing in the e-mobility transition. **In case study 1 further in this report**, more details can be found on this approach and the digital tooling they use for this.

3b. Existing digital tools for EV Mobility and Energy Planning.

We have made an overview of various digital tools that help with the needs and challenges of cities in integrated planning & regulation of e-mobility & energy systems. It is a comprehensive list, but not necessarily a complete list. It will act as a prelude to SCALE Task 2.6: Tool Development - Integrated EV Mobility and Energy Planning Tool.

The identified needs and challenges in this report are used as input for this. And in Task 2.6 we will do an assessment of all found digital tools and thus create an overview of how suitable those tools are for the needs & challenges that we have set out in this report. This as a basis for further Tool Development for SCALE Task 2.6

[6] Netherlands Knowledge Institute for Charging

The overview of the various tools we found thus far, and a summary of the specifications per tool, can be found in Appendix 3.

4. Examples of front runners approaches regarding future needs

4a. Approach towards V2G in Utrecht

European cities can learn from Utrecht's pioneering V2G approach by:

1. Encouraging collaboration and experimentation among stakeholders.
2. Establishing public-private partnerships for effective implementation.
3. Integrating bidirectional and smart charging technologies.
4. Adopting international standards like ISO 15118 for compatibility.
5. Ensuring vehicle compatibility through partnerships with car manufacturers.

Utrecht's experience demonstrates the benefits of a well-planned, collaborative V2G ecosystem in supporting sustainable and efficient energy use.

More detailed information on this specific approach can be seen in Case Study 3 in this report, on page 43.

4b. Oslo approach to stimulate private smart charging

The implementation of smart charging in Oslo has been stimulated through a well-designed subsidy scheme. This program has facilitated the installation of 80,000 wallboxes on private properties, enabling the city to reduce the stress on the (public) grid.

Under the scheme, users are responsible for purchasing the hardware, while the subsidies cover infrastructure costs. The program's administrators strive to identify the most cost-effective smart charging and battery solutions, previously offering 50% subsidies, which have now been reduced to 30% in support of infrastructure development. Additionally, valuable advice and guidance are provided to applicants throughout the process.

The Elbil Norwegian EV Association plays an important role here by offering services related to smart charging infrastructure advice. In fact, the growing demand for electric vehicles has made smart charging a de facto requirement for many households in Oslo, as they face limitations in available capacity. Numerous private companies have also emerged, offering smart charging solutions to meet this need.

As part of the application process, EV drivers submit requests for subsidies. Applications are thoroughly reviewed, and either approved or returned with a request for further evaluation. This innovative approach to supporting smart charging infrastructure in Oslo provides can provide a blueprint for other European cities looking to embrace smart charging solutions.

3.2.4 City needs & challenges regarding smart charging & V2G from authors experience and knowledge: Case Studies

Above we reported on relevant City needs & challenges that we have identified in numerous online resources. We also draw on the authors of this report's own knowledge and practical experience in the field of charging infrastructure, smart charging and V2G. This knowledge can be found in the three presented case studies below.

We want to share these case studies for information and inspiration for other European cities and regions that want or are already working on the topic of smart charging and V2G/V2X.

1. **CASE STUDY 1: Example of an Advanced EV-Charging City in need for integrated planning of e-mobility, energy networks & urban space – Amsterdam**
2. **CASE STUDY 2: Planning strategy – Utrecht**
3. **CASE STUDY 3: Bidirectional ecosystem - V2G – in Utrecht**

CASE STUDY 1: Example of an Advanced EV-Charging City in need for integrated planning of e-mobility, energy networks & urban space – Amsterdam

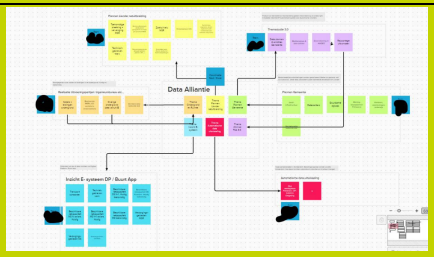
Once every 2 years, Amsterdam takes an inventory of the current load in Amsterdam and an inventory of all plans and ambitions and their impact on the electricity grid. It is called the Electricity Thematic Study. This inventory provides guidance on what Amsterdam will be working on in the coming period with respect to the planning, design and development of new Liander (DSO / grid operator) stations. The aim of the data alliance between Amsterdam and DSO Liander is to make the biannual moment more real-time and therefore to exchange plans and ambitions in a more structural way so that an up-to-date picture of Amsterdam is always created.

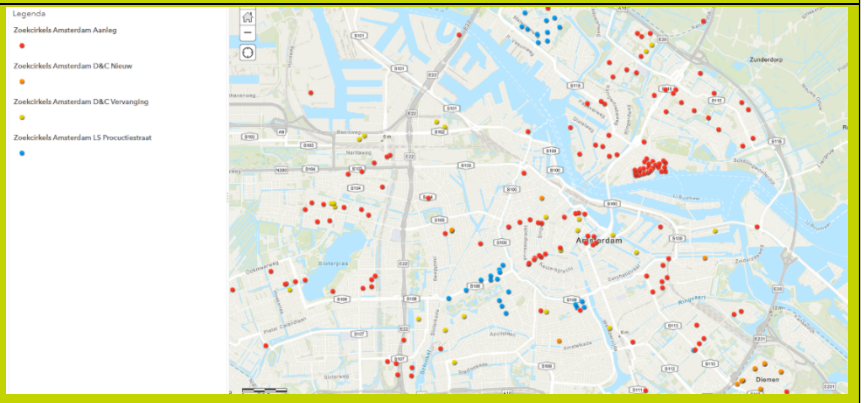
A concrete example of this is, for example, is the exchange of new construction plans of the City of Amsterdam. These plans change and shift on the assembly line. The sooner Amsterdam reports on that a project has been pushed back by a year, the sooner Liander's planning can take this into account and prioritize other projects (which are already glowing).

Below you can see an example of all projects that are collected on the data platform used for this data exchange (ESRI - GIS environment). These plans translate into maps (see Fig. 2). For example, Liander now specifies search circles where new transformer stations should be placed (search area). Then the area team of the City of Amsterdam can check within that circle what the most desirable place is (for instance).

Otherwise, Liander also provides the latest state of affairs regarding their underground infrastructure in the city, so that urban planners can take this into account in their new construction plans.

Within the ESRI Partnered collaboration, this data can be shared between the necessary parties in a secure environment.





CASE STUDY 2: Planning strategy – Utrecht

Insights and planning instruments

To support a transition to electric mobility, having a successful planning strategy is key. The setup of the strategy is a planning cycle that repeats itself every few years. It starts with forecasting that gives insight into the need for different charging infrastructure on a small geographical scale. This is translated into a spatial map of the city or region to give an overview of the needs and demand for infrastructure over the next years. This is then translated into policy and action (projects, concessions etc.) that need to come about in order to develop the needed infrastructure. In the next paragraphs these steps will be further enlightened.

Figure 21: Steps in planning and developing charging infrastructure for cities or regions

Step 1: Forecasting - For planning and developing a city or regional charging network insight in the future demand for charging infrastructure is needed. This insight can be obtained by forecasting the charging needs with a model. A forecast model for charging infrastructure predicts the charging needs for a city or region. The forecast can be made for various target groups: passenger transport, taxi and target group transport and logistics. The forecasts can cover both the need for electricity (in kWh) and the need for different types of charging infrastructure (regular charging, fast charging and ultra-fast charging). Each target group can charge at multiple charging locations: public or private, slow or (ultra) fast charging. The Utrecht forecast model used in this example shows the expected need on the basis of three spatial scale levels: neighbourhoods, highway corridors, and truck parks/depots. The latter translates into logistical charging demand.

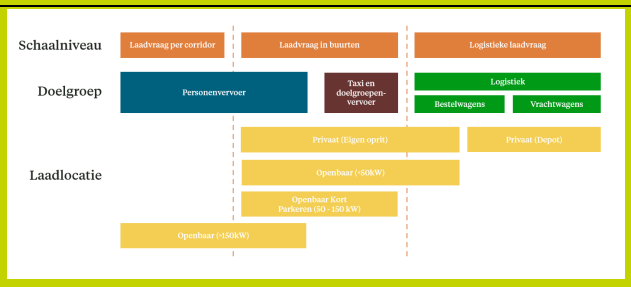


Figure 22: Target groups and charging solutions on different scales

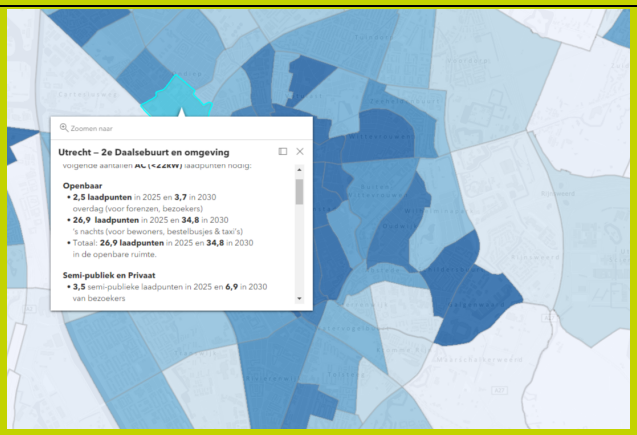


Figure 23: Map showing the charging demand in 2025 and 2030 for different neighbourhoods in Utrecht

The result is a map and an (Excel) database that gives insight into the amount of EV's in every neighbourhood for the coming 8 years that is translated into the amount of chargers of the different types in public and private space.

Forecasting EV adoption per target group

To calculate AC charging demand (destination charging) in neighbourhoods, a diverse set of data is used: statistics on incomes, car ownership, population density, and the percentage of own driveways. Based on those data points, each neighbourhood is given an EV adoption score that indicates the extent to which the neighbourhood will purchase above or below average EVs. The model then uses that EV score to determine how far the neighbourhood will deviate from the national average EV. By knowing what the EV percentage will be for each neighbourhood, and the percentage of homes with their own driveway, an estimation is made on how many EVs want to charge in the public space and how many in their own driveway.

For the AC commuter charging demand, it is estimated how many employees work per Chamber of Commerce registration. The presence of public parking spaces is calculated and the proximity to public transport for each business building in order to arrive at a good modal split estimate. In addition, we take into account the category of the business area, in order to distinguish between companies where we expect relatively many and few electric (lease) cars. For example, we estimate for each building how many employees will come with an electric car, and which part will park and charge on private and which part on public land.

The AC and DC visitor charging demand results from an extensive selection and analysis of relevant visitor locations. the number of visitors per location is estimated, based on the function, surface area, and key figures on parking generation. All locations are classified as 'relevant for AC' or 'relevant for DC short-term parking and charging', the latter mainly involving retail and sports locations. These are locations such as supermarkets, hardware stores and sports clubs where people are often there for an hour or less, and where fast charging can be properly facilitated.

We are adopting electric taxis and target group transport based on a growth and distribution model. Using vehicle registration data, we create a growth model at municipality level and distribute the number of electric taxis across the various neighbourhoods using "personas" that we have developed. For example, we know which electric taxis charge where at night and, with the help of knowledge about the percentage of private driveways per neighbourhood, we can estimate how many will charge on their own property and how many on public roads.

Forecasting AC and DC charging demand per neighbourhood

To translate all AC and DC charging demand into charging points, we use key figures (which can also be adjusted in the model) about the charging efficiency: how many users use each charging station? This differs per target group and per year. In 2030, for example, we assume that 1 charging point will be needed for every 8 visitors, while that is 6 to 1 for residents. This is partly due to the fact that batteries are getting bigger and need to be charged less often. On the other hand, the current group of electric drivers drives much more than average (26,500 km per year according to the Dutch National Charging Survey) while the Dutch national average is much lower (around 12,500 km per year). Because electric vehicles will become more and more common, the group of electric drivers will also become more diverse and will cover fewer kilometers on average and will subsequently have to charge less often. We take dual usage into account by first looking at the AC demand during the day and in the evening separately. Commuters and visitors charge during the day, while taxis and residents charge at night. The number of charging stations per neighbourhood is not the sum, but the largest value of the number of simultaneous daytime and evening charging sessions.

Forecasting charging demand on corridors

Part of the fast charging demand takes place on (motorway) corridors. Therefore the main road network is divided into different corridors. These are stretches of (fast) roads where the charging demand is virtually the same. To find out what the fast charging demand is on a corridor, three things are looked at: the number of EVs on that corridor, the chance that those EVs want fast charging, and the length of that corridor. By means of a national traffic model it's visualized which journeys are made with those vehicles and what their origin and destination are. By performing a 'Selected Link Analysis', we not only know the origin and destination, but also the route of the vehicles. As a result, we know which cars are driving in each corridor, their origin, destination and the distance, an estimate of the amount of kWh used and an associated fast charging opportunity. The further the ride, the greater the chance of fast charging. We then divide that fast charging opportunity and need among the corridors. The part of the journey that does not take place on one of the corridors is allocated to the inner-city fast charging requirement.

We expect the greatest need for fast charging in a corridor where many EVs make long journeys. For example, on the A2 between Amsterdam and Utrecht there are many vehicles that often make long journeys (for example from Alkmaar to Den Bosch). A high volume of EV combined with a high chance of fast charging leads to a high prediction of the number of required charging points. Corridors where many vehicles drive, but where they mainly make short journeys, are less prominent. For example, more than half of the EVs on the A4 between The Hague and Rotterdam are less than 50 kilometres away. On such a journey, the chance that someone wants to fast-charge while en route is very small, because electric cars usually have a much longer range. On the other hand, there are also corridors where the amount of vehicles is not that great, but the distance covered by those vehicles (and therefore the chance of rapid charging) is high. An example of this can be found on the A58 in the province of Zeeland, where fast charging demand is relatively high because many EV drivers come from outside the province (or even outside the country).

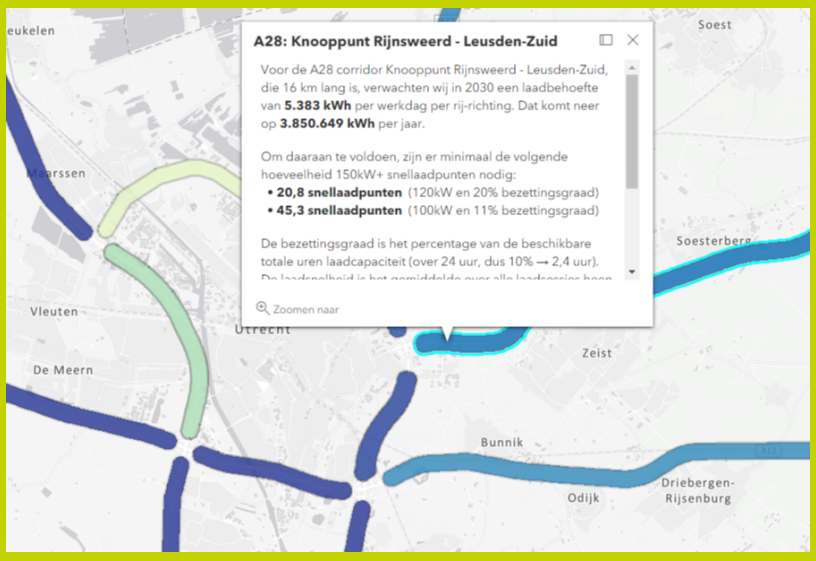


Figure 24: Map showing charging demand for corridors (highways) around Utrecht

Grid impact analysis - The municipality or regional authority can use the forecast for planning charging infrastructure. The DSO can use the forecast for a grid impact analyses. This analysis describes where bottlenecks are expected on the regional electricity grid as a result of growth through electric mobility, what possible measures there are to reduce the impact and solutions to prevent bottlenecks. A calculation has been made using forecasts supplied by the city and regional authorities on the development of mobility. These forecasts have been supplemented with expected developments for other sectors such as housing, industry, heating and renewable energy generation.

Grid operators take into account the maximum power peak in MW when constructing the electricity grid. This is the largest demand for power that is expected at the same time, for example due to the charging of electric cars, the use of heat pumps and the generation of electricity from solar panels. In order to simulate the impact of mobility as closely as possible within the integral calculation, charging profiles have been drawn up by knowledge institute and SCALE partner ElaadNL and the network operators for all modalities (passenger cars, logistics, public transport buses, construction equipment and inland shipping). A charging profile shows the power demand throughout the day. For example, the charging of electric passenger transport has the greatest impact in the morning and evening, while trucks at depots will charge regularly at night and cause short peaks during the day due to fast charging. The effect of smart (grid-aware) charging is reflected in a smart charging profile.

The analysis focuses on the grid areas of the regional grid operators. The electricity grid in the Netherlands has several grid levels. Electricity is converted to lower or higher voltage levels at various points in the grid. This is done by means of transformers in stations. The focus of this grid analysis is on the locations where high voltage is converted to medium voltage – in substations – and where medium voltage is converted to low voltage in the medium voltage transformation stations (MSR's). The analysis identified bottlenecks that will arise in 2030 at these substations and MSRs, partly as a result of mobility.

The analysis provides the grid operator with important insights into what developments are expected in the region and therefore forms important input for investment plans. When drawing up the investment plans, an additional extensive validation of bottlenecks takes place by the network operator and the solutions are worked out in detail.

STEP 2: Spatial translation and planning

After the forecast is finished, the results can be translated into a map overview. This map services as a vision document which the planning of roll out is based. The map shows the spatial spread of the different charging solutions in a stage five or ten years ahead. The map shows what is needed to facilitate the transition to electric mobility within a certain geographical area.

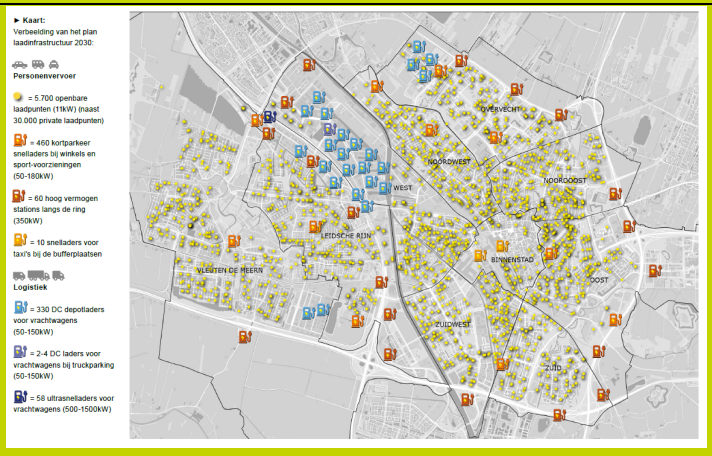


Figure 25: Charging map 2030 Utrecht

	Private		Semi-Public		Public	
	2025	2030	2025	2030	2025	2030
AC Regular (11 kW)	10.758	23.096	3.872	7.586	4.618	5.737
Kortparkeer (Short-term parking) (50-180 kW)	-	-	-	-	244	464
Taxi fast chargers (180 kW)	-	-	-	-	5	10
Corridor chargers ring road (150-800 kW)	-	-	-	-	-	60
DC Depot (50-150 kW)	83	330	-	-	-	-
Ultra High Power (>800 KW)	-	-	15	58	-	-

Figure 26: Charging table 2030 Utrecht

STEP 3: Policy & Action

The map serves as a point on the horizon and needs to be translated to a concrete program that exists of projects (plans, concessions, purchase etc.) for the different charging solutions. For that step the authority needs to define its role in the development of the different charging solutions and locations. For public locations the public authority has a very clear role in procuring or providing permits or concessions for the exploitation of charging infrastructure. For private locations the role is usually limited to stimulating the development of private chargers by providing information (publication of the forecasts), knowledge sharing and if needed grants. For the Utrecht example mentioned above, the forecast and plan led to the following actions that is translated into a program for electric charging infrastructure for the next 5 years:

- Upscale of roll out for public AC chargers to 20 - 30 chargers a month within current concession
- Upscale DC short-term parking from 19 to 30 locations
- Set up a concession for taxi chargers
- Set up a concession for truck parking (overnight and Megawatt-chargers)
- Procurement of semi public chargers in municipal public car-parcs
- Spatial exploration of locations corridor chargers along ring road
- Stimulate development logistics depot chargers
- Include forecasts in grid impact analysis grid operator

CASE STUDY 3: Utrecht V2G approach

Utrecht is the first city world-wide to implement the vehicle-to-grid (V2G) technology on a broad scale. Bidirectional V2G charging enables e-cars to both charge and deliver energy from car batteries back to the grid. This way car batteries become buffers for renewable energy and can help cope with congestion by balancing the grid. There is now a city-wide network of 500 bidirectional charging stations (1000 sockets) and 200 shared e-cars.

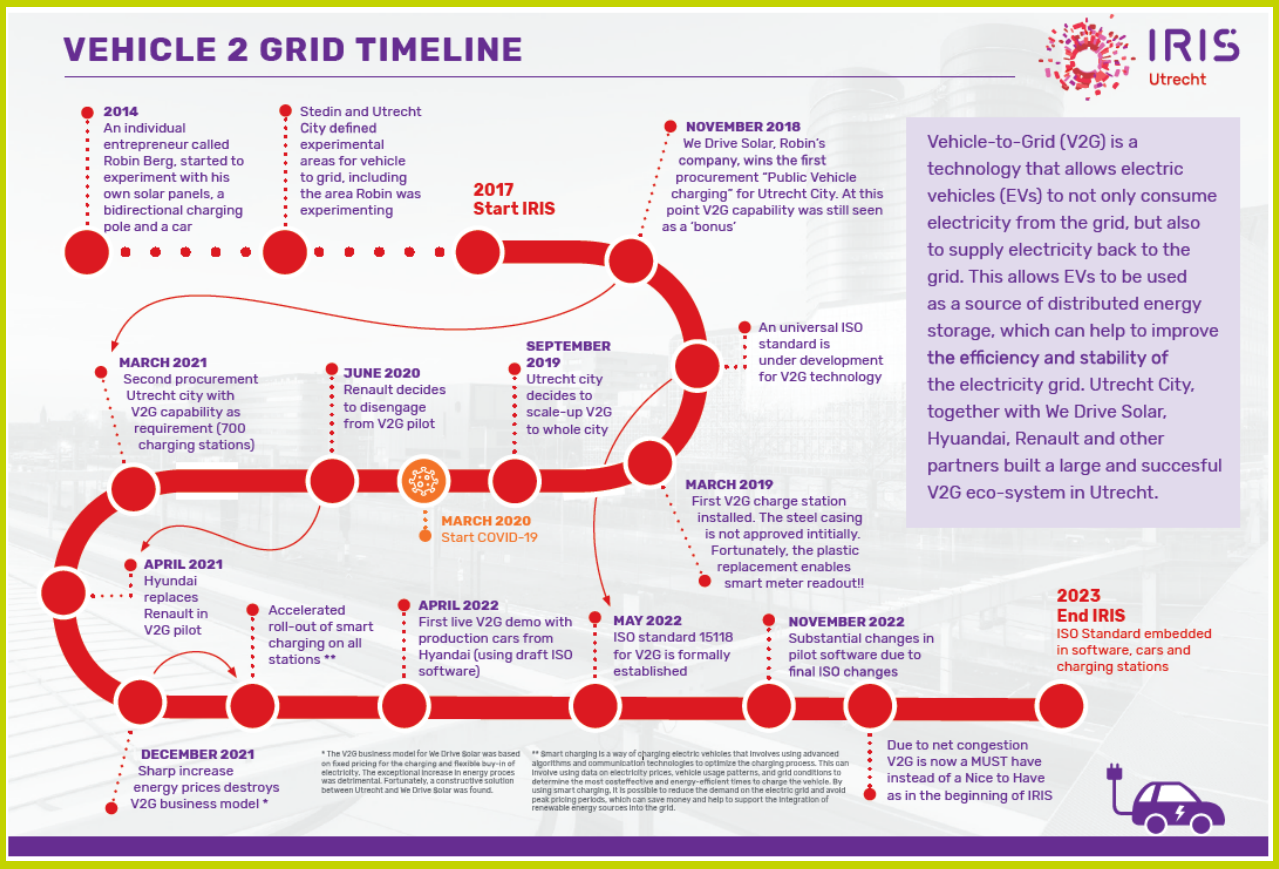
Back in 2014, it all started with entrepreneur Robin Berg experimenting with his own solar panels and his Nissan Leaf. Soon after, grid operator Stedin (DSO) and the city of Utrecht defined an experimental area for V2G charging, denoting their support for the promising technology. In 2018, Robin's e-car sharing company 'We Drive Solar' procured the public vehicle charging contract commissioned by the municipality of Utrecht. At the time, the V2G technology was considered a 'bonus'.

Since then, electrical demand in the Netherlands increased and is approaching net congestion, prompting the municipality to upscale V2G city-wide. Now, V2G is considered a 'must have' to balance the grid and avoid expensive grid reinforcements towards the end of the decennium.

Alongside bidirectional V2G charging, smart charging was also developed. Smart charging optimizes charging times according to electricity costs, vehicle type and grid conditions, decreasing the pressure on the grid. We Drive Solar was ideal to test charging techniques as car availability is known through their booking system. The recent sharp increase in energy price accelerated the roll-out of smart charging, resulting in all 500 public charging points now using the smart charging technology.

The system needs a bidirectional car. We Drive Solar initially partnered with Renault to prototype a bidirectional Renault ZOE. This was the first implementation worldwide of AC bidirectional charging based on the ISO standard 15118-20. In 2022 Hyundai joined the ambition of Utrecht, generating the world's first V2G-enabled production e-car: the Hyundai IONIQ5. The bidirectional option on the IONIQ5 was launched in April 2022 in Utrecht, again a world first.

Another important step in the worldwide success of V2G is compatibility. Development of a universal charging language started in 2019 and ensures that all manufacturers will produce compatible bidirectional cars and charging points. The ISO15118 standard was formally established in 2022. The only wait at time of writing (of this report) is the implementation of the final ISO15118 version into the Hyundai IONIQ5 cars, expected for somewhere in the upcoming few months. Then the bidirectional ecosystem is up and running and ready to scale quickly.



4. Conclusions

We identified a need for more information and guidance regarding planning strategy, procedures for mobility transition, public space, related tender procedures and hardware and software requirements for advanced EV charging infrastructure; smart charging with an extra interest in V2G. So there is a clear need for validated knowledge to support integrated planning of e-mobility and energy systems. Specifically, we identified the need for detailed requirements and blue prints for smart charging in different cities and regions.

A majority of respondents do not yet experience grid congestion, but do foresee that this will become a significant problem in the future. In addition, they see the implementation of smart charging and optionally V2G will be important to postpone or prevent the expected grid congestion. Academic research confirms this view. And there is a lack of knowledge about how to properly implement smart charging and optional V2G technology. Cities and regions see integrated planning for smart charging and vehicle-to-everything (V2X) services as essential for the sustainable development of European cities. In our SCALE research we identified main needs and challenges that cities face in this regard.

Charging infrastructure deployment and strategy:
Cities indicate a need for a clear strategy for the deployment of charging infrastructure that meets the needs of electric vehicle (EV) drivers while minimizing costs. This requires an understanding of EV adoption rates and travel patterns to identify the optimal locations for charging stations. That is why cities consider a mix of fast and slow chargers, as well as different (smart) charging technologies, to cater to the diverse needs of EV drivers. Collaboration with utilities and other stakeholders is also necessary to ensure a reliable and cost-effective power supply to the charging infrastructure.

Currently there is a wide variety of roll-out strategies, in the Netherlands there are many curb side AC destination chargers, Norway on the other hand provides a financial stimulus for private charging and Barcelona allows only DC fast chargers in public and requires destination chargers to be installed only on private ground. And everything in between (see interview outcomes). We can conclude that there is a need for a blueprint for at least smart charging specifications. For roll-out strategies it's a bit different, since strategies must be adapted to the local situation, like EV penetration, local grid constraints and for example the percentage of citizens who have access to private parking spots (for example that is 70% in Oslo and only 30% in Utrecht and similarly lower in Athens). Cities like Madrid, Barcelona and Stockholm are subsidizing public accessible chargers at private ground, which is an interesting solution for expanding a public charging network, but without having to sacrifice public space. Oslo also subsidizes private charging infrastructure, but without requiring that it is also guaranteed to be publicly accessible.

Smart charging and V2G:
Smart charging and vehicle-to-grid (V2G) technologies are critical to managing the expected future impact of EVs on the power grid. Smart charging can help balance the load on the grid by charging vehicles during off-peak hours and reducing peak demand. V2G technology enables EV batteries to be used as a storage resource for the grid, which can help integrate renewable energy sources and improve grid stability, in a cost-effective way. However, the deployment of these technologies requires significant investments, embedding in regulations and coordination among multiple stakeholders. Organizing this entire chain is seen as a major challenge.

Governance and regulation:
Cities want to know effective governance and regulatory frameworks, in coordination with other local and national governments, to promote the deployment of smart charging and V2X services. This includes establishing clear and

open standards for charging infrastructure and ensuring interoperability between different charging networks. Cities, regions, electricity grid operators, utilities and regulatory bodies need coordinated policies that support the integration of EVs into the power grid. Much relevant information regarding this need is available in online resources for this, but it is fragmented.

Grid constraints and energy management:
The integration of EVs into the power grid can create new challenges for energy management, particularly in areas with limited grid capacity (due to or not due to a high local percentage of EVs). Cities need to consider the impact of EV charging on the local distribution network and develop strategies to manage peak demand. This may involve the deployment of smart charging and V2G technologies, as well as the use of energy storage systems to balance the load on the grid. There is a need for higher level collaboration between cities and grid operators to manage the complexities of sustainability and digitization.

Public and private sector involvement:
The successful deployment of smart charging and V2X services requires the involvement of both the public and private sectors. Cities need to work with EV manufacturers, charging infrastructure providers, utilities, and other stakeholders to develop an integrated approach to EV deployment. Public-private partnerships can help facilitate investment and innovation, while also ensuring that the needs of both public and private sector stakeholders are met.

In summary, integrated planning for smart charging and V2X services requires collaboration and coordination among multiple stakeholders. Cities need to develop clear strategies for charging infrastructure deployment, leverage smart charging and V2G technologies to manage grid constraints, establish effective governance and regulatory frameworks, and involve both the public and private sectors in the process. In this report we reported on a variety of online resources which can help and inspire cities regarding these needs and challenges. Also the planned outcomes of the SCALE project, are a direct fit with the identified needs and challenges.

Grid operators
Furthermore it is important to underline the critical role of DSOs for the successful deployment of electric vehicles (EVs) and related services such as smart charging and V2X. DSOs are responsible for various enabling factors for the upscale of electric mobility, including grid development and charger connections.

DSOs face several key challenges, including smart grid planning, active system management, security, efficiency, reliability, renewables integration, (legacy) technology and data management, flexibility, and smart asset management. Addressing these challenges requires collaboration, policy and regulation alignment, and stakeholder engagement.

DSOs play a vital role in integrating EVs into the energy system and ensuring seamless, efficient, and sustainable growth. Their involvement in the planning and development process, in collaboration with TSOs and City planners, is crucial for delivering the environmental benefits of EVs, cost savings, and timely infrastructure development.

Knowledge gap
We found a knowledge gap regarding planning strategy, procedures for the e-mobility transition, related tender procedures and specifically hardware and software requirements for advanced EV charging infrastructure. There is a clear need for validated knowledge to support integrated planning of e-mobility and energy systems. Blue prints. A clear example for this need from the interview came from Greece, where the DSO mentioned they adopted the UK strategy for charging infrastructure.

Most respondents and reports foresee grid congestion will become a significant problem in the future. And that the implementation of smart charging and optional V2G will be important to postpone or prevent the expected grid congestion. But there is a lack of knowledge about how to properly implement smart charging and optional V2G technology.

Need for advanced and dynamic integrated planning
Cities and regions in more advanced EV Charging phases indicate they need integrated planning tooling. There are many digital tools available in the field of integrated planning of e-mobility and energy systems, but it is unclear to what extent these are applicable to the needs of cities and regions and their grid operators with regard to advanced integrated planning. So information can be exchanged - ongoing - between the city/region and the grid operator(s), instead of once per couple of years.

There is a need to have insight into expected bottlenecks, which can for example be visualized on a map in a digital environment. That layered map can show the energy infrastructure, sustainable generation (windmills, solar roofs), housing, large logistics companies, bus sheds, development of charging network for passenger transport, mobility hubs, etcetera. And the upcoming developments in this regard. This in order to be able to make an integrated planning. And if things change - such as due to the postponement of the construction of a residential area - the expectations regarding the bottlenecks in time will also be immediately adjusted and made transparent. Dynamic. So that grid reinforcements in specific places can be pushed back, for example, and others can be pushed forward. Enabling dynamic prioritization. Because the need is there to manage the complexity properly and efficiently in an advanced EV maturity phase. Amsterdam started with a digital tool for this purpose and the Province of Utrecht is developing a tool. And other advanced EV charging cities like Oslo also indicated they are in need for this to keep in control of the accelerating e-mobility transition.

5. Recommendations

Recommendation 1: accelerate and scale up the dissemination of knowledge about smart charging and V2X services

Targeted dissemination among European cities and regions of validated knowledge and publications of EV Charging front runners and cooperating partners, such as knowledge institutes and universities, could facilitate the deployment of smart charging and V2G/V2X infrastructure. This would be particularly beneficial for cities and regions in Europe that are in a start-up or scale-up phase with regard to charging infrastructure. Examples of information that are needed are: Blue prints such as the 'Smart Charging Requirements' from NAL or 'Standards for EV Smart Charging, a guide for local authorities' from ECOS and RAP. And information specifically related to V2G: Utrecht's approach to this, as described in this report.

The recommendation therefore is for the forerunners and proponents of EV transport to share knowledge and proven approaches on a large scale. The V2X alliance that is envisaged as a deliverable in the SCALE project may be a very good vehicle for this. It is therefore recommended that this particular SCALE task is properly implemented. And we recommend developing a European online knowledge center, where all relevant and reliable information in the field of smart charging and V2X services is collected and maintained. It is recommended to start this up in the short term and to not wait until the end of the project. Because cities, regions and their grid operators are already waiting for that knowledge. And the sooner that validated information is distributed on a large scale, the sooner knowledge and smart charging specifications will be included en masse in tenders, etcetera. Doing so helps accelerating the preparation of the European grid for the mass roll-out of electric vehicles. Which is essential for achieving the CO2 reduction targets in different cities, countries and the EU as a whole (Green Deal).

A strong recommendation here is to formulate SMART policy objectives. For example, in 2025 an X% of European cities must make the smart charging requirements mandatory in tenders for public and semi-public charging stations.

Recommendation 2: sync with other cities and assess available digital tooling

The results of the research we have done in this Work Package (1.3) will be used to develop digital tooling in Work Package 2.6. This aims to address the needs and challenges we found in the SCALE research and enable smart data sharing between stakeholders such as the DSO and urban planners. The research has shown that cities and regions in more advanced EV charging phases have a need for this. And more and more European cities and regions are entering that phase. An important recommendation here is to assess two essential issues before starting to build such a tool:

1. Which cities and regions are known where they are already using or developing this?
2. Which digital tools have already been developed and are in use for integrated E-Mobility and Energy network Planning?

And to test this with the City needs & Challenges that we have identified in this report. In the research for this report, we identified that Amsterdam and the Province of Utrecht are developing or using such a digital tool. And we also came across a lot of tools in the research that might be useful in the execution of Task 2.6. These can be found in Appendix 3.

So the recommendation is to synchronize, and where useful to collaborate with others, and only after extensive assessment of already existing tooling to design the roadmap for tool development in Work Package 2.6. This all with the goal in mind to create a scalable Integrated E-Mobility and Energy Network Planning tool, which can serve as a blueprint for all European cities and regions.

Recommendation 3: Solve the V2G chicken-egg problem for smart charging and V2G, for hardware and software, with the policy 'super' power of the EU

Almost all respondents consider smart charging to be essential in the short or medium term for the electricity grid in their cities to be able to manage the expected growth of electric transport. This is also reflected in the (online) resources used in the research. Smart Charging has the potential to manage the load of EVs in such a way that it will hardly be an extra load for the grid. And that is hugely helpful because the grid is already facing major challenges due to the electrification of other sectors and the large-scale integration of sustainable energy.

Smart Charging is therefore a no-brainer and it is therefore important to have every charging station in Europe smart charging ready. Therefore we highly recommend - based on the identified city needs & challenges - to upscale the Smart Charging Requirements (SCR) to an European level. And with this providing the commitment that in the period up to 2030 only charging infrastructure will be rolled out that is Smart Charging Ready. These requirements also include V2G requirements for hardware and software. This emerged in our research as a highly anticipated need among the respondents to obtain reliable information about this.

The biggest obstacle, however, is the chicken-egg problem in terms of hardware, but also for software. Smart charging and V2G ready charging stations need sufficient smart charging and V2G ready vehicles, and vice versa. In short: the hardware and software for V2G need a soft power push.

The EU is a regulatory superpower. From Emission standards, to the energy efficiency of vacuum cleaners, the latter of which has led to enormous energy savings without sacrificing suction power. A similarly stimulating and possibly mandatory smart policy around smart charging, including V2G, could be the soft power push needed to solve the chicken-egg problem surrounding V2G hardware.

Recommendation 3a: smart charging requirements at European level for public and semi-public charging stations.

For the benefit of the needs and challenges of European cities and regions, we therefore recommend using EU policy power for mandatory regulations for the implementation of smart charging requirements at European level for public and semi-public charging stations. And a smart incentive policy for private charging stations.

Recommendation 3b: requirements for EV models to be V2G ready, starting with high end models.

EU soft power can also help solve the chicken-egg problem for hardware and software on the car side. More and more electric vehicles are equipped with Vehicle-to-Load technology (V2L). Relatively little adjustment is needed on the car side to make V2L also suitable for V2G. Smart policy, for example by mandating that V2L in high-end models is also suitable for V2G, can also be the soft power push to solve the chicken-egg problem for hardware and software on the car side. The extra costs for EV manufacturers are estimated to be very limited for this. And by making this mandatory for high-end models, the technology can trickle down to low-end models afterwards.

Recommendation 4: incentivize publicly accessible charging infrastructure on private land, with smart charging requirements as an additional condition.

Cities struggle with sacrificing public space for charging infrastructure. Cities such as Barcelona, Madrid and Stockholm are therefore encouraging private charging infrastructure that is publicly accessible. Subsidizing charging infrastructure on private land - charging stations and/or the installation costs - but with the condition that it is publicly accessible, is an alternative way of realizing a comprehensive charging network. This is an interesting strategy to implement in addition to or instead of a charging network consisting of charging stations all along the city streets. For AC (destination) chargers as well as for DC (fast) charging stations.

It is important here to also set smart charging requirements as a condition for the subsidy. So that the vehicles in this growing public/private charging network are smartly charged and the electricity grid is thus spared. And intelligent monitoring of the impact of the subsidy is important here.

Recommendation 5: implementing stricter energy efficiency policy for electric vehicles – EV Euro standards

The main objective of SCALE is to prepare the European electricity grid for the massive uptake of electric vehicles. Smart charging & V2G are resources that contribute to this. Because the electricity grid is used (more) efficiently with these technologies. So efficiency is the main topic here. That is why we also want to mention this fifth recommendation in this report. Because there is a direct link between smart charging & V2G and energy efficiency of vehicles: both help the main goal of 'an efficient electricity grid that can facilitate the massive uptake of electric vehicles'.

All energy that is used unnecessarily is wasted. And the less electricity we need to drive our electric vehicles, the more cost-efficiently we can roll out and manage our electricity networks. It helps reducing the pressure on the (local) electricity grid, like smart charging and V2G/V2X are doing but then in a different way.
The European Union has had a successful policy of implementing ever stricter emission standards for fossil fuel vehicles over the years, the so-called Euro standards. This has stimulated and forced the car industry to develop increasingly fuel-efficient vehicles, which has significantly reduced the emission of harmful substances from road traffic.

In a similar way, the electric car industry could be stimulated and eventually forced to make electric models more and more economical. Now there are large differences in efficiency between manufacturers of electric vehicles. And the trend is that many electric cars fall into the SUV category and are larger and heavier than necessary. And even within the same category there are big differences in energy efficiency. For example, a Jaguar Ipace (223 Wh/km) is much less energy efficient per km driven than a Tesla Model Y (172 Wh/km), even though they are of a comparable size. The difference is about 23%! (Source: EV-database.org)

It is therefore recommended to develop a stimulating and ultimately mandatory policy with regard to energy efficiency for electric vehicles. The successful Euro standards can be an inspiration for this: EV Euro standards. This can significantly reduce the pressure on the local electricity grid in European cities and regions. And it also ensures that fewer raw materials are needed for batteries, including critical minerals.

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Appendices

- **Appendix 1 - Respondents' description of the SCALE survey**
- **Appendix 2 - SCALE Research Interviewees**
- **Appendix 3 - Examples of Integrated EV Mobility and Energy Planning Tool**
- **Appendix 4 - Interview key points**
- **Appendix 5 - Interview guideline – Cities/Regions**
- **Appendix 6 - Interview guideline – DSOs/TSOs**
- **Appendix 7 - Survey questions – Cities/Regions**
- **Appendix 8 - Survey questions – DSOs/TSOs**

Appendix 1 Respondents' description of the SCALE survey

	Job position	City or region	Country	Organization type
1	City officer	Madrid city council	Spain	Local city administration
2	Senior Policy Advisor for the environment	City of Arnhem	Netherlands	Local city administration
3	Expert-Advisor mobility policy responsible for strategic mobility planning	City of Leuven	Belgium	Local city administration
4	Head of Unit	Environment and Health Administration, City of Stockholm	Sweden	Local city administration
5	Expert on charging infrastructure / decarbonization of transport in Berlin	Berlin	Germany	(Specialized in) Local city administration
6	Strategic advisor zero emission mobility, specialised in charging and electric mobility	Municipality of Rotterdam	Netherlands	Local city administration
7	Policy consultant charging infrastructure	City of Utrecht	Netherlands	Local city administration
8	Deputy director of energy and climate change environment and mobility area	Madrid city council	Spain	Local city administration
9	Director of electric mobility strategies	Barcelona city council	Spain	Local city administration
10	Mobility Advisor	Pisamo Srl	Italy	Local city administration
11	Green energy transformation expert	Tallinn city government	Estonia	Local city administration
12	Deputy head of Environment and public works department	Tallinn City Goverment	Estonia	Local city administration
13	Mobility strategist	Örebro Municipality	Sweden	Local city administration
14	Urban mobility processor	Stadt Bielefeld	Germany	Local city administration
15	Trade Economist	Općina Dobrinj	Croatia	Local city administration
16	Mobility manager	Žilina	Slovakia	Local city administration
17	Project manager, universal design	City of Gothenburg	Sweden	Local city administration
18	Program Manager e-mobility	City of Gent	Belgium	Local city administration
19	Programmanager Energy transition in Mobility	Province of Utrecht	Netherlands	Regional authority
20	Consultant for emission-free mobility	City of Aachen	Germany	Local city administration
21	Project coordinator	City of Turku, Mobility services	Finland	Local city administration
22	EU projects department	Municipality of Florence	Italy	Local city administration
23	Technician in Municipal Department on Energy and Climate Change	Murcia City Council	Spain	Local city administration
24	Manager Electro Mobility	City of Oslo, Agency for Urban Environment	Norway	Local city administration

Appendix 2 SCALE Research Interviewees

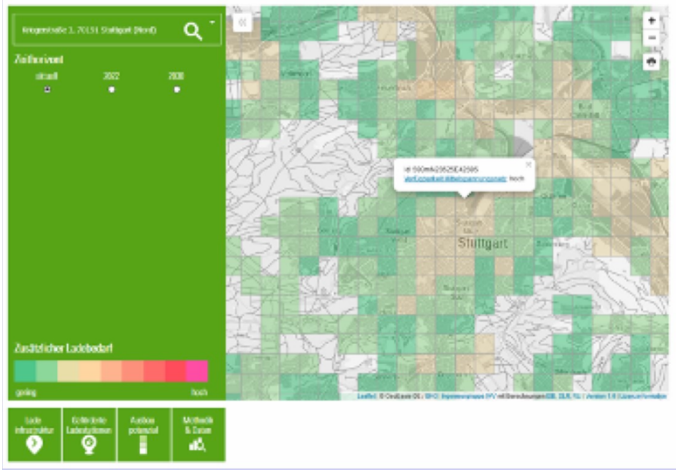
	Job position	Company name	Country	Organization type
1	Business development expert	CEZ Distribuce	Czech Republic	DSO
2	Head of electromobility section	Hellenic Electricity Distribution Network Operator S.A.	Greece	DSO
3	Data scientist (system operations)	TenneT TSO (Netherlands)	Netherlands	TSO
4	Smart grids leader	UFD (Naturgy Group)	Spain	DSO
5	R&D lead, energy engineer.	JSC Sadales Tikls, Latvia	Latvia	DSO
6	Business consultant	Terna S.p.A.	Italy	TSO
7	New Technologies Head	DTEK Grids	Ukraine	DSO
8	Network Innovation division head	MVM DEMASZ, MVM EMASZ	Hungary	
9	e mobility consultant	Enedis	France	DSO
10	Senior grid development specialist for emobility	PREdistribuce, a. s.	Czech Republic	DSO
11	Development strategist, Electrification, mobility.	Göteborg Energi / GENAB	Sweden	DSO
12	Advisor Flexibility Usage	TransnetBW GmbH	Germany	TSO
13	Network planning engineer	GENAB	Germany	DSO

Appendix 3 Examples of Integrated EV Mobility and Energy Planning Tool

Germany: grid transparency through StandortTool

The StandortTool, an online planning tool created by the German federal government, enables the planning of recharging infrastructure by providing a map of Germany divided into small rectangular zones with different colors. Each zone's color corresponds to its level of need for additional recharging infrastructure, ranging from dark green (lowest need) to pink (highest need).

The StandortTool uses data on the existing vehicle fleet, recharging infrastructure stock, and mobility patterns of German drivers to provide an accurate assessment of the need for recharging infrastructure in each zone. Additionally, for each zone, the tool provides information on the possibilities of connecting to the medium voltage grid, allowing potential investors to estimate the costs of connecting a recharging station to the grid at any location.



Furthermore, the StandortTool makes projections for future expected needs, covering a time horizon of 2022 and 2030. By doing so, the tool ensures that the deployment of recharging infrastructure keeps pace with the expected demand. Investors can use this tool to plan the deployment of recharging infrastructure in a way that aligns with the projected demand and take into account the associated costs of connecting to the grid.

Figure X: StandortTool
Source: https://www.standorttool.de/

INTEMA.grid

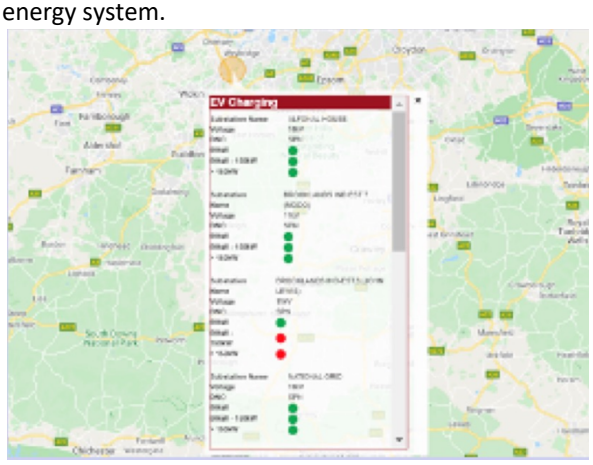
INTEMA.grid is a digital tool developed by the Centre for Research and Technology Hellas (CERTH) in Greece to help cities and utilities plan for the integration of electric vehicles (EVs) and charging infrastructure into their transportation systems. The tool focuses on grid planning and management, with the goal of optimizing the use of renewable energy sources, minimizing the impact on the electricity grid, and reducing greenhouse gas emissions.

The tool simulates the deployment of EVs and charging infrastructure and predicts the resulting power demand on the electricity grid, taking into account the availability and distribution of renewable energy sources. It also analyzes the potential for energy storage solutions, such as batteries and smart charging systems, to help balance the electricity grid and reduce the need for costly grid upgrades. Overall, INTEMA.grid is a valuable tool for cities and utilities looking to integrate EVs and charging infrastructure in a sustainable and cost-effective way.

Mapping grid capacity: UK Open Power Networks

The UK Open Power Networks project issues maps detailing the grid's hosting capacity for recharging points with different power levels (50kW, 100kW, 150kW). Mapping recharging demand on these locations will reveal cost-optimal locations that need the least public support.

UK Power Networks' Open Networks project is a digital platform that provides access to real-time data on the distribution network, enabling new energy services and technologies to connect to the grid. The platform is designed to enable greater collaboration between network operators, energy suppliers, and technology providers, with the aim of accelerating the transition to a low-carbon energy system.



Through the Open Networks project, UK Power Networks aims to develop a more flexible and efficient electricity grid, capable of supporting the integration of renewable energy sources, electric vehicles, and other distributed energy resources. The platform provides access to a range of data, including network capacity and availability, voltage levels, and fault data, enabling energy companies and technology providers to develop innovative new services and products.

In the context of integrated shared and private EV mobility and EV charging infrastructure rollout, the Open Networks project could be useful for cities and other stakeholders looking to interact with the energy network in order to manage the demand for electricity from EVs. By accessing real-time data on network capacity and availability, cities can better plan for the deployment of EV charging infrastructure and ensure that it is integrated with the grid in a way that minimizes disruptions and maximizes the use of renewable energy sources.

Source: UK Power Networks: https://dgmap.ukpowernetworks.co.uk/site/?q=ev_ext

Spark Tool

The Spark Tool is a digital tool developed by the Technical University of Eindhoven in the Netherlands to help urban planners and policymakers create sustainable urban transportation plans. It analyzes mobility patterns, travel behavior, and congestion to evaluate the effects of various mobility scenarios and policies. The tool can also identify the most suitable locations for EV charging stations and simulate the impact of EV charging on the electricity grid. While the Spark Tool can provide some useful insights into grid planning as it relates to EV charging infrastructure deployment, it should be used in conjunction with other specialized grid planning tools for a comprehensive analysis.

Gridscape

Gridscape offers a software platform that provides real-time monitoring and management of EV charging stations, helping cities to optimize their charging infrastructure and reduce operational costs. The platform offers features such as billing and payment processing, scheduling and reservation management, and analytics and reporting. Gridscape also enables cities to interact with additional energy networks, such as heating/cooling and gas, through its open API architecture.

EVCI-LO

EV Charging Infrastructure Location Optimization Tool (EVCI-LO), developed by the National Renewable Energy Laboratory (NREL). EVCI-LO is a web-based tool that allows users to identify optimal locations for EV charging infrastructure based on factors such as travel patterns, population density, and existing infrastructure. The tool uses a range of data sources, including GIS data, demographic data, and traffic data, to identify the most suitable locations for charging infrastructure.

EVI-Pro

The Electric Vehicle Infrastructure Projection (EVI-Pro) tool, also developed by NREL. EVI-Pro is a GIS-based tool that allows users to model the deployment of EV charging infrastructure under different scenarios, such as changes in EV adoption rates, fuel prices, and government policies. The tool can help cities to plan for future charging infrastructure needs and identify potential infrastructure gaps.

EV Energy

EV Energy, by Hitachi ABB Power Grids: EV Energy is a cloud-based software platform that helps cities plan and manage the rollout of EV charging infrastructure. The platform provides a range of services, including site selection, charging station design, energy management, and data analytics. It also enables interaction with additional energy networks, including heating/cooling and gas.

ChargeIQ

ChargeIQ, by Delta Energy Systems: ChargeIQ is a smart charging solution that optimizes the use of EV charging infrastructure. It allows cities to manage the demand for charging, forecast congestion, and plan for infrastructure rollout. The platform also provides real-time data analytics and reporting, enabling cities to monitor and optimize the use of their charging infrastructure.

GridPoint Mobility

GridPoint Mobility, by GridPoint: GridPoint Mobility is a cloud-based software platform that helps cities manage the rollout of EV charging infrastructure, optimize energy consumption, and reduce costs. The platform provides real-time data on energy usage and charging patterns, enabling cities to forecast congestion and plan for infrastructure rollout. It also allows for interaction with additional energy networks, including heating/cooling and gas.

ChargeNet

ChargeNet, by Siemens: ChargeNet is a digital platform that helps cities plan, manage, and operate EV charging infrastructure. The platform provides real-time data on charging station availability and usage, enabling cities to forecast congestion and optimize charging capacity. It also enables interaction with additional energy networks, including heating/cooling and gas.

Teralytic

Teralytic is a sensor-based platform that helps cities optimize the use of their transportation infrastructure, including EV charging stations. The platform uses sensors to collect data on temperature, humidity, and soil moisture, enabling cities to manage their infrastructure more effectively and plan for infrastructure rollout. It also enables interaction with additional energy networks, including heating/cooling and gas.

InnoEnergy

InnoEnergy is a European innovation engine that helps cities and businesses accelerate the transition to a sustainable energy future. The platform provides support for the development and rollout of EV charging infrastructure, as well as energy management and forecasting tools. It also offers education and training programs to help cities and businesses develop the skills they need to manage their energy infrastructure effectively.

Appendix 4 – Interview key points

City or Organisation	Country	Key Findings
City of Arnhem	The Netherlands	• Participated in CleanMobilEnergy project: smart charging (use of solar energy for charging). Did a charging plaza (connected locally produced RE), could use charging infrastructure for V2G. • The goal of V2G should be the storage of locally produced renewable energy • We Drive Solar cars in Arnhem are scattered and do not work as V2G currently • Working on creating new self-sufficient neighbourhoods, in these areas V2G could be interesting • Current strategy: accelerate the number of charging points. Fear that if there are not enough, it will slow down EV adoption. Different strategies according to locations: new developments, older town, North of the city (see interview) • Working on growing charging infrastructure in parking garages • Issues with grid congestion: hard to get heavy connections to the grid. The grid is saturated already. • Main barrier to upscale V2G: the cars are not adapted/ready • Work closely with the region & at the national level • Charging location: on-demand by the citizens + they have a map of desired locations • Participatory processes with neighbourhoods in North Arnhem Working on a sustainability plan, hope it will be a SUMP + they have a transition programme up until 2030
Barcelona Regional (public agency for strategic, urban and infrastructure planning led by Barcelona City Council)	Spain	• No V2G pilots, difficult to get technology and cars. More concerned with how people will react/act to V2G, they have tested it with Wallbox and Nissan. • Very interested in smart charging • Municipal company: BSM. It is does charging infrastructure. • They mostly install chargers in parkings & fast chargers in the public space (parking is free for fast chargers). Around ¼ of parkings that are publically accessible are owned by BSM. Only the council can install chargers in the street. • Thinking of creating a mixed company: BSM + a private company. This could grow amount of chargers. • Battery swapping program for shared motorcycles • Working with electric taxis to have a specific CPO and chargers on street for them. • Investment in grid congestion a challenge • Previously had a platform for stakeholders to meet: Life Platform. Created in 2010. • V2G and smart charging for slow chargers in AC. Big push on having the public sector lead e-mobility/charging infrastructure.
Stad Leuven	Belgium	• Before, the grid operator Fluvius had to implement charging infrastructure tendered by the region (Flanders) with Allego (CPO) • In 2021, new ambitions at regional level: 30 000 charging points • The tender process was done at the Flanders level with all accepting except 3 cities (Ghent, Antwerpen and Genk) • City of Leuven not really involved in negotiation of tender • There are 2 CPOs in the contract • Concession is for 2 years, after they don't know if they will do a concession at local or regional level • On-street charging should be the last resort. Focus on fast charging in public space. • Very keen on smart charging: they have linked the energy RE production and EVs Shared mobility hubs: multimodal + has EV car sharing + charging infrastructure

City of Stockholm	Sweden	• V2G has been tested in Sweden: pilot in Kungsbacka. Conclusions were not positive, still many issues in implementation
		• Stockholm: low interest to o a trial, not a priority, more focus on day-to-day operations
		• Governance:
		  ○ On-street charging: access right agreements with stakeholders, 10 year contract, criterias. Currently 7 operators in Stockholm. They have a map of desirable locations.
		  ○ Off-street: parking company "Stockholm Parkering" that is owned by the city, they have a lot of charging facilities. They are required to add charging in new garages.
		  ○ Real estate companies within the city (eg, sports areas, swimming pools): thay also have to equip parking with charging.
		• Currently doing a street light posting charging pilot, particularly in outskits
		• Information campaigns for installation of charging in householders/appartments + trainings, events with suppliers, etc.
		• Most of municipal fleet is electric, but its very small

		• Procurement: EVs required or have to be put as a short term goals • 2030: Stockholm municipality must be a fossil free organization • Energy grid an issue: need to shave the peak. But complicated jurisdictionally & hard to get stakeholders on board • Congestion charge: no difference between ICE and EV in Stockholm. This is kept like this at the national level (congestion charge is implemented at national level), city wants to change it but its challenging. For e.g. creating a ZEZ or LEZ • Very high public acceptance of EVs and charging infrastructure • Stockholm: 17% cars are chargeable. High growth estimates: 50% by 2030 • Currently: over 4 000 public charging points (2022) • High reliance on private sector for charging points installation, operation and maintenance. Not the role of a city. Interested in V2G, but low probability of introduction in near future. Interested to follow SCALE's results.

City of Tallinn	Estonia	• Beginning of charging deployment
		• Estonia started with charging stations 12 years ago & today they have 300 charging stations. City of Tallinn: 100 charging stations.
		• Regulation to have charging stations in new buildings (since 2015)
		• A new charging infrastructure structure is ready, awaiting political approval. It will have enforcement component.
		• Grid network: charging infrastructure is not an issue, does not put pressure
		• Incentives to purchase EVs: but only limited to 200-300 cars, slow uptake of EVs.
		• Pilot: City of Tartu & CalTech on microgrids/smart grids and emobility. Microgrids: reducing energy supply requirements using microgrids and energy storage (taltech.ee)
		• Fast chargers: ELMO program
		  ○ *The ELMO program: long-term instrument to encourage the wider adoption of EVs in Estonia. Financed by a CO2 emission trade agreement between the Estonian government and Japan's Mitsubishi Corporation under the Kyoto Protocol, the total budget for the nationwide infrastructure development and 5-year maintenance was approximately € 12m.*
		  ○ *In order to establish this nationwide charging infrastructure, the government asked financing and program management agency KredEx to procure a turnkey technical solution with a 5-year operational agreement from private providers. In addition, KredEx was responsible for finding and securing locations for chargers and ensuring that electricity-grid companies built sufficient power connections to those locations. All subtasks within the program were procured from private companies.*
		  ○ *ELMO was officially launched in mid-summer 2011 and included three main parallel processes to develop locations; grid connections; and turnkey solutions for chargers and an IT system and service set-up. The tender for the turnkey solution was won by a consortium led by multinational power engineering corporation ABB(link is external) that included software partner NOW! Innovations(link is external) and service operator G4S.*

Madrid City Council	Spain	• Similar approach to Barcelona: restrictions in use of public space by private companies, city ensures public space is used for public sue (charging seen more as a private use). • City Council provides fast chargers to private stakeholders to install on private land but publically accessible (e.g. petrol stations, hotels, etc). • On-street: only fast chargers (24 points). Currently doing a concession to have 36 extra points. They are facing challenges in selecting an operator because the price/benefits are so different between each offer. Electric mobility - Demanial concession call for the installation of electric vehicle charging points on public roads - Madrid City Council • Upcoming plan: create hubs of fast chargers with private stakeholders (e.g. Uber): charging points for private use + charging points for taxis/ride hailing • City Council works with the 2 DSOs in Madrid for location of charging points • Charging infrastructure is decentralized: national government does not play a big role
EMT Madrid	Spain	• EMT: Madrid's transport operator, in charge of buses & parking (amongst others) • *I have some info on bus charging, power grid, etc but I did not focus on this too much because not the scope. FYI Madrid's bus fleet is 100% electric, second city in Europe with most ebuses* • Charging in parkings (publicly accessible) • Canalejas 360: innovative electric mobility hub of the capital. The ambitious project promoted by the Madrid City Council and managed by the EMT • Most powerful urban EV charger in Spain: 12 charging points from super fast (400kW) to 50KW Issue: only limited amount of vehicles have the capacity to use these chargers. The hub responds to a future demand.

Tennet (TSO)	Netherlands / Germany	• Important: "Wouter speaks in a personal capacity. In the report we can refer to him as "Data analyst at Tennet, in a personal capacity"
		• The Netherlands needs between 3 and 800 MW of control capacity, depending on the time and date. Suppose each car produces 7Kw. Then you can do the math, then you don't even need that many electric vehicles in relative terms.
		  ○ Calculation: 800 MW = 800,000 kW -> 800,000 kW divided by 7 kW = 114,286 electric vehicles (batteries) at the maximum moment.
		  ▪ Addition of respondent after checking the interview texst: I can't really find that 800MW…could just be 1500MW (absolute peak). Regulating upwards (feeding in) is more difficult than regulating downwards (turning off production), because less available.
		• Biggest Challenge: Market models and roles. BSP: balance responsible party and CSP, congestion service provider. Responsible parties, assets, how do you measure data. What used to be aggregators are now BSP and CSP. Parties are now certified by TenneT as BSP or CSP, eg Edmij is designated by TenneT as congestion service provider. The challenge is how to arrange that with each other. In the ecosystem. Who pays what when and why. Starts with the rolls. Validated. See also: https://www.mffbas.nl/
		• Technically I'm not worried. It is all technically possible and everything has been piloted in terms of roles. But growth in scale is what is needed. So that complexity is also out.
		  ○ Small projects are nice, but need to be big.
		  ○ Make it as simple as possible to scale it up, easy to use. Because people want it financially. But convenience is even more important.
		• If the battery is connected via a NON Firm ATO, that it adheres to our control signal (from Tennet and/or DSO) when it really has to - for example 60 hours per year.
		• Most important advice from him on the subject of EV smart charging and V2G: Don't see it as a problem. But as an opportunity. Embedding EV is challenging, but it can actually (!) help with the solution. Think not so much in terms of problems, but in what it yields; better for air quality, it is a car/vehicle with balancing capacity and can therefore absorb peaks and troughs.
		• We need everything. V2G is one of the possible interesting solutions in what we need in terms of balancing power. Plus: financially interesting for the driver.
		Everyone uses AI for forecasting of the grid load (machine learning and neural networks etc), but it is getting more and more difficult, because the behavior is becoming more and more dynamic.

CEZ Distribuce (DSO)	Czech Republic	• The situation in the Czech Republic is that cities and regions are not yet involved in planning for charging infrastructure. Charging infra is mostly done by utility companies, CPO's. They are focusing mainly on fast chargers, and few of them on destination charging. But we know that in the near future also cities and towns need to be involved. • Requirement is when a charging hub is above 100kw it needs to be connected to the DMS system,, so receiving the signal from the DMS. Mostly for emergency situations, so not for smart charging yet.We are on our way. • Distribution Management System, controls the grid. To potentially limit the power. But it should be more dynamically in the future, not just for emergency situations. • We are piloting different kind of smart charging with different policy and schemes. But our main focus now is how to build a lot of chargers. • Lacking information or knowledge? -> Definitely about V2G. Recently we were familiar with DC wallbox V2G. I wasn't aware about AC V2G. A European blueprint for smart charging would be helpful
Sadales tīkls (DSO)	Latvia	• Smart meters for all customers (approx. 1 million). • Main challenges: rise of rooftop PV, bidirectional flows, driven mostly still by regulatory changes. If the government introduces a new scheme for stimulating rooftop PV for example, then that has a lot of impact on us due to rapid increase in workload and required process changes. And the flexibility market is something we are currently looking at. Congestion services. Implementing internally to have the network ready for it by 2025. • Netting will be phase out, new customers from 2024 will get a diffent arrangement – net billing. Instead of netting kWh, the retailers will net Eur value of the import/export value at the given hour. • Prognoses are a guess game. It's super tricky. You can make a prognoses based on data like household incomes in certain areas and other data points, but the honest answer is we don't do this. • We can try to build bigger linces in advance to meet the future demand, but we are afraid of over investment in case demand for capacity doesn't arrive. • We really think in annual terms even for multi year projects. No time to go back and look whether what was done 5 years ago has paid off. Targets we are trying to achieve are annual described.. So it's mostly reactive. We hardly have time to think as we are mostly solving operational challenges, innovation unit was established only this year. We are very conservative. And penalised hardly for mistakes.

		• If you can figure out to take more risk, or even incentivised to take risk, that would be great. It should change, but how?
		• V2G we are looking into that, but demand should come from the market.
		• The challenge is the regulation. We want to facilitate it but at the moment for CPO - they have to pay for the reserved load capacity but the utilisation of public chargers is low, so CPOs struggle to recover the costs
		• Dynamic load balancing is a default feature that CPOs implement to request lower capacity from Sadales Tikls. We are investing how to come up with more flexible tariffs.
		• Big hurdle is the process of new IT system in DSOs. We have legacy systems deeply in our systems. Every new system needs to connect to these systems, otherwise it is useless.
		• On what subject are you lacking information or knowledge?
		  ○ What are front runners doing (NL, UK, Germany) on the topic of EVs and charging infrastructure. We would like to learn from front runners. Flexiblity services, integration, smart Grids. How to facilitate implementation of smart grid techology. Optimal usages of the network. Integration with 3th party systems.
		• Focus points now:
		  ○ Short term: multi objective optimisation. Not just minimalize the losses or maintain the voltages. How to integrate multiple objectives. Realtime. Grid automation. Improving efficiency

PREdistribuce (DSO)	Czech Republic (biggest DSO in Czech Republic)	• High scenario is basically what is now in EU parliament, banning new Gas cars in 2035. • In high scenario, in 2040, if acceleration will be intensive, in 2030ties we need to do aggressive investment to be able to facilitate all the chargers if we are not able to introduce smart charging. If we can introduce smart charging then there still will be extra investment, but significantly lower. • Heating: When we phase out natural gas it will have a huge impact. Especially in cities. • In the CR we are a bit different. For boilers and heating we send high frequency signals throughout the grid and we can start or stop specific kinds of loads. Much more urgency is in PV right now (several GW of installed power in applications for connection to be assessed).
Province of Utrecht (region)		• There are many different interests in the chain. Charging CPO/MSP as quickly as possible and as much kWh as possible, that is a different interest than with smart charging and V2G. • So make it cheap, or a lot of convenience or gain in the form of status, etc. and then you can help change behavior in the right direction. • Grid manager Stedin is very positive about V2G, which is why we also want to actively communicate about it and promote V2G • It has been agreed that the provinces will play an important role in accelerating the development of the network and prioritizing demand. • Provincial multi-year infrastructure program for energy and climate. Process in which the province looks at the built environment, mobility, sustainable generation, industry and agriculture. What will happen in the next 5 years and what does that mean for the network. What does this also mean for spatial procedures to accelerate them and what flexibility can we find in the system to continue as much as possible. V2G and smart charging is also included in that last part anyway. And that's what the conversation is about. But not the volume for V2G to have an impact before 2030, but I expect smart charging within 2 to 3 years. Because it helps shift electricity consumption and thus uses limited capacity more efficiently. • This program really driven by the congestion problem. Discussion with the Dutch minister for climate and energy Jetten about the regional assessment framework, under the direction of the province about what to prioritize (eg hospital priority in terms of connections to companies). The first integrated planning will be delivered at the end of March. The expected bottlenecks are drawn in the map of the province of Utrecht. energy infrastructure, sustainable generation, housing, large logistics companies, bus sheds, development of the charging network for passenger transport. All those layers as a kind of map layers over it. Where the windmills, solar roofs etc. Need this integrated planning.
Transnetbw.de (TSO)	Germany, Baden-Württemberg,	• TSO/DSO cooperation. Where does really the renewable energy come into the network. One interface. Where are the EVs really connected to the grid. Whole ecosystem needs to talk and exchange trusted data. • Were it does not work well, is privacy and security regulation. Not proactive to start and look at the regulation afterwards. For example smart meter roll out. How can a country like Germany has just 1% penetration. Difficult to roll it out. People don't want it. It's also a cultural thing, "I don't want to share my data". You see the same discussion about enabling the DSO to reduce the load in emergency situations on charge points.

		• You have a TSO planning and a DSO planning. EVs of course effect the TSO network as well. How do we handle it, in the end we make assumptions and do communicate about it. Network planning. Digitalization, platform for IT solutions. This is all involved in that. At this point in time of course it is important to have data from EVs but in the future we need more data from the DSO network to run our systems as well. Data exchange is also the key, decentralized production and consumption form EVs heatpumps etc. We need to know more realtime information about that when the load of it grows.
HEDNO S.A. (DSO)	Greece (whole country)	• We have some very good ideas of what is going on in other countries, like the Netherlands. We are on good level as Greece regarding the regulatory framework on electro mobility, we're keeping good pace. Not as advance as Holland, but the regulation and framework is there. The good thing is that we try to gain experience and not make the same mistakes. We try to make our own mistakes • Biggest challenge is not only e-mobility or upgrading the connection, but the actual labor. • On the upperlevel we don't have to do reinforcement on high to medium voltage level. But mainly on the low voltage. And if we have increase of fast chargers also reinforcements on the mid voltages. • So basically we are laying the fundament for enabling smart charging. • So for our side regarding dynamic pricing for e-moblity we will be up and running at the end of the year. As a DSO we then will offering the metering data. • The other thing as a challenge for us also in the big cities since they are old cities there aren't much private spaces for parking. So we want to go for a similar model as in Holland • European regulation says they need to implement the facilitation of flexibility services. DSO should develop a monitoring and management system that should let's say communicate with market players regarding the charging infrastructure. And provide and purchase flexibility services so we avoid unnecessary infrastructure upgrades. • The problem is that we should development at some time a new system that manages the load of the chargers somehow, a system that also includes congestion issues. And this will be a challenge for the organisation. Because right now we already facing difficulties with the measuring of the low voltage, smart meters for the households. Challenge for a big organisation to transform. I'm not pessimistic about the grid DSO, but in general about DSOs since they are slow moving organisations. • Mainly the bus and transportation companies within the cities which will be electrified. And will request significant new connections at the depots. And there is a big conversation here in Greece about electrifying the Vessels. That will be a significant load for us. To install 10.000 charging points nation wide for the upcoming 2 or 3 years. And they are now writing the tenders for municipalities. And they are going for the basic stuff. 1 CP per 1000 habitats. What we have done is together with ministry of energy, it's mandatory for all public charging to have an open protocol for smart charging. This law was applied in the UK initially, we implemented that idea as well.
Enedis	France (95% of the coutry)	• Main challenge of smart charging in general is to align everyone. • Most important challenge is to shift the charging of EVs to off peak hours, today that is the night. But that will change when for example solar will catch up more and more. We need to incentivize consumers (like EV drivers) to charge at different times or regulated this more via regulation. • First objective is 'peak shaving' for evening peak around 7pm, and shift those loads to the night. • We have in France also different grid tariffs. We have variable grid tariffs between peak and off peak. But we need to increase the difference between peak and off peak tariffs in order to encourage users to charge during off peaks. • If no smart charging at all there will be congestion. But basic smart charging will be sufficient. Avoids 30% of reinforcement, with basic smart charging, rescheduling it to off peak hours. Next to energy efficiency of buildings. First sort out V1G. Not in a hurry for V2G. And of course people who want to do self consumption may go for this solution. But for the grid it is not needed now. We joined SCALE to learn. But is a topic we follow, because we think it has potential for the future.
City of Oslo	Norway	EV Adoption in Oslo • 90% of cars sold last year were battery electric vehicles • Approximately 35% of all cars in Oslo are battery electric Private Charging Infrastructure • 80,000 wallboxes supported on private ground • 70% of Oslo citizens have access to private parking

		Public Charging Infrastructure • 3,200 AC outlets, around 1,600 chargers with double outlets • Many DC fast chargers in Oslo, with a 50/50 profit model between charging operator and the city • Subsidy scheme for smart charging infrastructure: 50% to 30% subsidy for infrastructure City Needs & Challenges: Integrated Planning for Smart Charging and V2X Services • Grid limitations at the local level leading to struggles with peak energy demand • Necessity to streamline and optimize e-mobility, spatial planning, and the local energy grid for a sustainable future • Increased interest in V2G technology for housing cooperatives and shopping malls • Need for advanced digital tooling to replace current manual methods like Excel for integrated planning Grid Limitations • National and regional grid is good, but local grid faces challenges • Struggling with peaks and increased energy costs Grid capacity tariffs varying for peaks (higher price) and lows (cheaper)

Appendix 5 - Interview guideline – Cities/Regions

Identification of overarching needs and challenges of cities in integrated planning & regulation of mobility & energy systems. a survey and focus group interviews will be conducted to collect data on needs and challenges of 30 stakeholders (e.g., city& regional planners, DSO, TSO) and added value of V2G and smart charging in different cities.

1. What is XX current status in regard to public charging? Smart charging? V2G? What is the vision and where you are at?
2. What is the main barrier to upscale smart charging and V2G?
3. Do you have any incentives for people to charge their EVs at specific locations or time? Or to purchase an EV? (at the local or regional scale)
4. How are you adapting to the pressure EVs put on the grid? Are you testing any technologies or regulations?
5. How do you cooperate with the region? Do you learn from or work with other cities in your region?
6. Question on ownership, operation, maintenance and revenue streams of charging infrastructure + on tendering processes (according to answer in survey).
7. E.g. “e: From the survey, you stated that your municipal CPO does the operation, the maintenance and the financing of the infrastructure, etc., You do a lot through the public sector and don't delegate that much to the private sector. What is the reason for this? What are the benefits and drawbacks?”
8. Which departments work on emobility in your municipality/region and how do you coordinate? Are there any challenges? E.g. the mobility department, the energy department, the digital department, etc.?
9. How is public acceptance in XX for charging infrastructure? Do you do any information campaigns? Meetings? Workshops?
10. Do you have any strategies linked to charging? (E.g. mobility, climate strategy, SUMP, etc.) How were they defined?
11. Are there any cities or policies in Europe that you have inspired yourself from?

Appendix 6 - Interview guideline – DSOs/TSOs

Identification of overarching needs and challenges of cities in integrated planning & regulation of mobility & energy systems. a survey and focus group interviews will be conducted to collect data on needs and challenges of 30 stakeholders (e.g., city& regional planners, DSO, TSO) and added value of V2G and smart charging in different cities.

1. Double check: DSO / TSO?
2. Privacy questions; (how) can we mention you in the report? View of company or in a personal capacity?
3. What are the biggest challenges in preparing the grid for the mass uptake of Electric Vehicles in your vision?
4. What needs does this bring to you as a TSO/DSO?
5. What are their needs and challenges for integrated planning for the further uptake of EV and other electrification?
6. Which uncertainties are there? What are the most important ones? What in your vision needs to be done to lower these uncertainties?
7. What are the different responsibilities in the chain of stakeholders according to you? Do the stakeholders work well enough together? Like TSO/DSO/Cities/Industry players?
8. Are the DSOs cooperating in a structural manner with the TSO on grid reinforcement in your area?
9. What do you think is going really well on this topic?
10. And what is maybe alarming according to you?
11. Based on what are you planning the grid improvements? Prognoses? Input
12. Do you have an impact analysis for the electrical grid in your distribution area? Sufficient? And scope 2030/2050
13. What would help you? Digital tooling?
14. Are there specific requirements regarding the charging infrastructure you actively advise or even demand in your area?
15. Charging network interoperability-...Smart charging ...Vehicle to Grid (Security measures, Privacy measures ask them specifically on their vision and actions on V2G
16. Interesting projects tested on Smart Charging or V2G?

Appendix 7 - Survey questions – Cities/Regions

Planning requirements and implementation of public EV Smart Charging and V2G infrastructure

Welcome **SCALE is a Horizon Europe Project with a budget of around 10 million EUR that aims to scale up smart charging and Vehicle-to-Grid (V2G) infrastructure to facilitate the mass deployment of electric vehicles (EVs) in Europe and support the energy transition.**

To enable the scaleup, we need to identify the needs and challenges of a range of stakeholders – including city & regional governments, distribution system operators (DSO) and transmission system operators (TSO). This survey and additional expert interviews are the used methods for this.

This survey focuses on publicly accessible EV charging infrastructure for battery-powered electric vehicles.

The results of the survey will inform the development of a planning blueprint in SCALE, i.e. guidelines and software tooling - for integrated planning of smart charging and Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) infrastructure for cities & regions.

Filling in the survey also offers you the opportunity to get updates on the SCALE project and/or become part of a V2G network alliance. And you can win a prize. ;)

Your input is very valuable for the mission of preparing the European charging infrastructure in a smart and interoperable way for the mass deployment of EVs.
Time to fill in: approximately **10 – 15 minutes** Thank you very much in advance.

The SCALE team
www.scale-horizon.eu

Start of Block: 1) General

GDPR & privacy

○ **By ticking this box, you give your consent for the SCALE project to use your data for research purposes. All answers will be confidential and not shared with or sold to third parties, the data will be stocked in a secure way by Rupprecht Consult solely for and during the duration of the SCALE project (2022-2025). This survey is conducted in compliance with the European General Data Protection Regulation (GDPR). For further information,contact Shreesha Vaidhya (s.vaidhya@rupprecht-consult.eu)** (4)

B1 **1) General**

Q1 **What is your name? (optional)**

_____

_____

_____

_____

_____

Q2 **What is your gender?**

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

Q3 **What is the organisation type you work for?**

- ○ Local city administration (1)
- ○ Regional authority (2)
- ○ Distribution system operators (DSO) (3)
- ○ Transmission system operator (TSO) (4)
- ○ Other: [please fill in] (5) _____

Display This Question:

If What is the organisation type you work for? = Distribution system operators (DSO)

Or What is the organisation type you work for? = Transmission system operator (TSO)

Q3b **Since you are a DSO/TSO please end this survey and continue to this specific survey:**

Needs, planning requirements and development for public EV Smart Charging and V2G infrastructure.

Thank you for participating.

We are looking forward to seeing the results of the survey fitting your organisation type.

Page Break

Q4 **What is the name of the local or regional government you work at?**

_____

_____

_____

_____

_____

Q5 **What is your position in your organization? What is your expertise?**

_____

_____

_____

_____

_____

Q6 **What is the population of your city or region?**

- ○ Less than 50 000 people (1)
- ○ 50 000 - 250 000 people (2)
- ○ 250 000 - 500.000 people (3)
- ○ 500.000 - 1 million people (4)
- ○ Over 1 million (5)

Q7 **How would you describe EV deployment and charging infrastructure in your city or region?**

- ○ **Not developed** (very small proportion of EVs and a minimal charging infrastructure) (1)
- ○ **Starting up** (upcoming proportion of EVs and an expanding charging infrastructure) (2)
- ○ **Average** (average proportion of EVs and average charging infrastructure for a European city/region) (3)
- ○ **Scale-up** (a high proportion of EVs and reliable coverage of charging infrastructure) (4)
- ○ **Pioneer in Europe/advanced** (a way above the average proportion of EVs and innovative charging infrastructure) (5)

End of Block: 1) General

Start of Block: 2) Charging Strategies and Vision

B2 **2) Charging Strategies and Vision**

Q8 **Do you have a strategy in place for the roll-out of public charging infrastructure?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Not sure. (Tell us more [optional]) (3) _____

Q9 **Is public charging infrastructure part of wider strategic plans (sustainable urban mobility plan, energy transition strategy, etc.)**

- ○ Yes. (1)
- ○ No. (2)
- ○ Not sure. (Tell us more [optional]) (3) _____

Q10 **What are the main focuses of your city/regions in regard to public charging? (multiple options possible)**

- ☐ Roll out public charging stations throughout the city to increase EV usage (1)
- ☐ Getting an area-wide general charging station coverage (2)
- ☐ Tap into private sector capital to roll out public charging points (3)
- ☐ Integrate EVs into the wider mobility solution (4)
- ☐ Increase revenues for your city/region (through charging fees) (5)
- ☐ Increase the amount of on-street public charging (6)
- ☐ Reduce the amount of on-street public charging (7)
- ☐ Investigate the use of electric vehicles plugged into public charging to stock renewable energy and balance the grid (8)
- ☐ Create an interoperable charging infrastructure (9)
- ☐ Others: (10) _____

Q11 **In your opinion, is this strategy adapted to the growth of electric vehicles in your city/region?**

_____

_____

_____

_____

_____

Q12 **Does the strategy also focus on home charging, workplace charging or commercial freight charging ? Do you have any key regulations, incentives or mechanisms in place for these?**

Q13 **Please link to the strategy, if publicly available:**

End of Block: 2) Charging Strategies and Vision

Start of Block: 3) Tendering processes for charging infrastructure

B3 **3) Tendering processes for charging infrastructure**

Q14 **Are you familiar with tendering processes for charging infrastructure?**

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Are you familiar with tendering processes for charging infrastructure? = No

Q15 **Who owns, operates and/or maintains public charging infrastructure in your city/region?**

_____

_____

_____

_____

_____

Q16 **Who is financing the charging infrastructure in your area?**

- ○ Who is financing the initial investment? (5) _____
- ○ What is the duration of the contract? (6) _____
- ○ Who determines the price for the end user? (7) _____
- ○ Do you have any relevant information that you would like to share regarding financing of charging infrastructure in your city/region? (8) _____

Q17 **Does the local or regional government you work for do procurement in regard to public charging?**

- ○ Yes. (If so, for which activities?) (1) _____
- ○ No. (2)
- ○ Don't know. (3)

Q18 **What procurement processes does your local or regional government use for public charging? (multiple options possible)**

- ☐ Open tendering (competitive tendering open to all) (1)
- ☐ Restricted/selective tendering (invitation to suppliers to procure, not open to all) (2)
- ☐ Negotiated tendering (inviting a single supplier to deliver the work) (3)
- ☐ Open Market Model (4)
- ☐ No procurement (5)
- ☐ Other (6) _____
- ☐ Don't know. (7)

Q19 **Are there specific requirements regarding the charging infrastructure that your region includes as requirements in tenders? 1/2**

Charging network-to-charging network interoperability (Enabling customers to use charging stations across different charging networks. Enabling them to start and stop charging via just one charge-pass/-id/-app) (1)	▼ Mandatory (1) ... Not Mandatory (3)
Smart charging (the speed and timing of charging electric cars can be adjusted using smart technologies. Charging can be at maximum rate most of the time and may be reduced or even stopped if there is a peak in the power demand, thus preventing overloading of the grid.) (2)	▼ Mandatory (1) ... Not Mandatory (3)
Vehicle to Grid (V2G) charging (One step further from 'smart charging' is even using the car to provide extra power to the grid when the demand is high (Vehicle to Grid/V2G). This way, we can ensure in the near future we will be charging millions of electric cars without any problems and in a sustainable manner.) (3)	▼ Mandatory (1) ... Not Mandatory (3)
Security measures (4)	▼ Mandatory (1) ... Not Mandatory (3)
Privacy measures (5)	▼ Mandatory (1) ... Not Mandatory (3)

Q20 **Are there specific requirements regarding the charging infrastructure that your region includes as requirements in tenders? 2/2**

	Yes (1)	no (2)	Don't know (3)
Smooth Integration with the electric grid (Glad to hear more from you if you know more details about this) (4)	○	○	○
Use of renewable energy (5)	○	○	○
Other specific reuqirements (Do let us know more if you would like to (Optional)) (6)	○	○	○

Q21 **Is there a need or an interest for your local or regional government in joint procurement?**

- ○ Yes, on a regional level. (1)
- ○ Yes, on a national level. (2)
- ○ Yes, on an international level. (3)
- ○ No. (4)
- ○ Don't know. (5)

End of Block: 3) Tendering processes for charging infrastructure

Start of Block: 4) Predictions and roll-out plans

B4 **4) Predictions and roll-out plans**

Q22 **Does your city or region have up-to-date predictions for the growth of EVs in your area? (up-to-date in the sense that these predictions are usable for policy and planning.)**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub) region (4)
- ○ Not sure. (3)

Q23 **Do you have a rollout plan for AC EV charge points in your area (destination charging)?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub) region (4)
- ○ Not sure. (3)

Display This Question:

If Do you have a rollout plan for AC EV charge points in your area (destination charging)? = Yes.

Q24 **Rate your AC roll out plan is sufficient for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

Q25 **Do you have a roll out plan for DC EV charge points in your area (fast charging)?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub) region (4)
- ○ Not sure. (3)

Display This Question:

If Do you have a roll out plan for DC EV charge points in your area (fast charging)? = Yes.

Q26 **Do you rate your DC roll out plan is sufficient for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

End of Block: 4) Predictions and roll-out plans

Start of Block: 5) Grid challenges

B5 **5) Grid challenges**

Q27 **Is electricity grid congestion (grid overload) a problem in your city/area?**

- ○ Major issue (1)
- ○ Issue (2)
- ○ Not an issue (3)

Q28 **Does your city/region have an impact analysis for the electricity grid in your city/area?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub)region (4)
- ○ Don't know. (3)

Display This Question:

If Does your city/region have an impact analysis for the electricity grid in your city/area? = Yes.

Or Does your city/region have an impact analysis for the electricity grid in your city/area? = No.

Or Does your city/region have an impact analysis for the electricity grid in your city/area? = Don't know.

Q29 **Please explain your answere here:**

_____

_____

_____

_____

_____

Display This Question:

If Does your city/region have an impact analysis for the electricity grid in your city/area? = Yes.

Q30 **Do you rate your impact analysis is sufficient for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

Display This Question:

If Does your city/region have an impact analysis for the electricity grid in your city/area? = Yes.

Q31 **If yes, what is the scope of that analysis? (ticking multiple options is possible)**

- ☐ 2025 (1)
- ☐ 2030 (2)
- ☐ 2050 (3)
- ☐ Other (4)

Display This Question:

If Does your city/region have an impact analysis for the electricity grid in your city/area? = No.

Q32 **Why not?**

- ○ No need for in our opinion (1)
- ○ No time invested in yet (2)
- ○ No budget for it (3)
- ○ Lack of cooperation with the DSO (4)
- ○ Lack of cooperation with the TSO (5)
- ○ Other: (please fill in) (6) _____

Q33 **Do you assume that electricity grid congestion will become a larger problem in your city/area in the upcoming years? (ticking multiple options is possible)**

- ☐ Yes, it already is (1)
- ☐ Yes, in the short term (2 to 5 years) (2)
- ☐ Yes, in the medium term (5 to 10 years) (3)
- ☐ Yes, in the long term (Beyond 10 years) (4)
- ☐ No, I don't think so. (6)
- ☐ Don't know (7)

Q34 **How do you value the cooperation between the local government you are working for and your local DSO (distribution system operator) regarding electricity grid reinforcement?**

- ○ Very good (1)
- ○ Good (2)
- ○ Neutral (3)
- ○ Slightly problematic (4)
- ○ Quite problematic (5)
- ○ Don't know (6)
- ○ Please clarify your valuation: (7) _____

Q35 **Do you cooperate with your TSO (transmission system operator) on grid reinforcement?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Don't know. (3)

Display This Question:

If Do you cooperate with your TSO (transmission system operator) on grid reinforcement? = Yes.

Q36 **How do you value the cooperation?**

- ○ Extremely high (1)
- ○ High (2)
- ○ Neutral (3)
- ○ Low (4)
- ○ Extremely low (5)
- ○ Please clarify your valuation: (6) _____

Q37 **Are you using or considering smart charging* or Vehicle-to-Grid (V2G)^ to balance tensions on the grid?**
* Dynamic charging based on Ev Battery State of Charge (SoC), Power availability, etc.
^ EV supplying the excess energy stored in the battery back to the grid

- ○ Yes, smart charging is implemented (1)
- ○ Yes, smart charging and V2G are implemented (2)
- ○ Yes, smart charging is considered (3)
- ○ Yes, smart charging and V2G are considered (4)
- ○ No (5)
- ○ Don't know (6)

Display This Question:

If Are you using or considering smart charging or Vehicle-to-Grid (V2G)^ to balance tensions on the... = Yes, smart charging is implemented*

And Are you using or considering smart charging or Vehicle-to-Grid (V2G)^ to balance tensions on the... = Yes, smart charging and V2G are implemented*

And Are you using or considering smart charging or Vehicle-to-Grid (V2G)^ to balance tensions on the... = Yes, smart charging is considered*

And Are you using or considering smart charging or Vehicle-to-Grid (V2G)^ to balance tensions on the... = Yes, smart charging and V2G are considered*

Q38 **Please tell us more:**

_____

_____

_____

_____

_____

End of Block: 5) Grid challenges

Start of Block: 6) Testing of smart charging & Vehicle-2-Grid innovations

B6 **6) Testing of smart charging & Vehicle-2-Grid innovations**

Q39 **SCALE is testing use cases in four Innovation Clusters: Home Business/Office Light and Heavy duty Public for which smart charging and Vehicle-to-Grid (V2G) is either already playing a significant role or will become a necessity in the next years. Each use case will focus on a different aspect to ensure complementarity and range. Detailed information can be found on our website**

Are there EV Charging projects/demonstrations in your area which are relevant in this respect? Please tell us more and provide links to online information if possible/available:

_____

_____

_____

_____

_____

End of Block: 6) Testing of smart charging & Vehicle-2-Grid innovations

Start of Block: 7) Knowledge gaps & needs

B7 **7) Knowledge gaps & needs**

Q40 **On what subject are you lacking information or knowledge? (ticking multiple options is possible)**

- ☐ Location planning for EV charging stations (1)
- ☐ Predictions for EV charging demand per suburb (2)
- ☐ Predictions for grid constraints (3)
- ☐ Digital tooling for this subject (locations planning, grid constraints, etc). (4)
- ☐ Validated tender procedures for EV smart charging infrastructure (5)
- ☐ Validated tender procedures for Vehicle-to-Grid charging infrastructure (6)
- ☐ Information on different market models to consider in Tenders. (7)
- ☐ Information on hardware requirements for EV smart charging infrastructure (8)
- ☐ Information on software requirements for EV smart charging infrastructure (9)
- ☐ Information on hardware requirements for Vehicle-to-Grid charging infrastructure (10)
- ☐ Information on software requirements for Vehicle-to-Grid charging infrastructure (11)
- ☐ Defining the strategy on how to let grow the EV charging network (Strategic placement, demand-driven placement, data-based placement, etc.) (12)
- ☐ Other: (13) _____
- ☐ Not clear for me what we are lacking (14)
- ☐ I don't have a lack information or knowledge on this subject. If so, where do you get your information/knowledge from: (15) _____

End of Block: 7) Knowledge gaps & needs

Start of Block: 8) Interview?

B8 **8) Interview?**

Q41 **Thank you for your time and actively partaking in our survey! Can we approach you for a short interview (max 30 minutes, via videocall or phone) to dive deeper in your needs and challenges? If yes, please provide your e-mail address and/or phone number for the purpose of making an appointment for this interview:**

- ○ **E-mail address:** (1) _____
- ○ **Phone number:** (2) _____
- ○ **No, please do not approach me for this** (3)

Q42 **Are you interested in getting involved or staying updated on the project?**

Then you can: Join the movement by expressing your interests to be part of SCALE Reference Group/V2X Alliance/Joint Procurement Program and get an insider's perspective on SCALE's innovative work, direct access to our findings and connect with experts in the field of smart charging and bidirectional charging (V2G/V2X) Join the SCALE LinkedIn Page to not miss any of the exciting developments happening in the project, to share your thoughts and take the conversation of smart charging and V2G/V2X ahead! Do you want to subscribe to the SCALE newsletter to get trimestral updates straight in your inbox?

Stay tuned for further updates!

- ○ **Yes, please!** (4)
- ○ **No, thank you.** (5)

End of Block: 8) Interview?

Start of Block: Block 9

B9 Thank you very much!

The SCALE team

www.scale-horizon.eu

Do you have feedback or want to let us know anything else?

_____

_____

_____

_____

_____

End of Block: Block 9

Appendix 8 - Survey questions – DSOs/TSOs

Needs, planning requirements and development for public EV Smart Charging and V2G infrastructure

Welcome **SCALE is a Horizon Europe Project with a budget of around 10 million EUR that aims to scale up smart charging and Vehicle-to-Grid (V2G) infrastructure to facilitate the mass deployment of electric vehicles (EVs) in Europe and support the energy transition.**

To enable the scaleup, we need to identify the needs and challenges of a range of stakeholders – including city & regional governments, distribution system operators (DSO) and transmission system operators (TSO). This survey and additional expert interviews are the used methods for this.

This survey focuses on publicly accessible EV charging infrastructure for battery-powered electric vehicles.

The results of the survey will inform the development of a planning blueprint in SCALE, i.e. guidelines and software tooling - for integrated planning of smart charging and Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) infrastructure for cities & regions.

Filling in the survey also offers you the opportunity to get updates on the SCALE project and/or become part of a V2G network alliance. And you can win a prize. ;)

Your input is very valuable for the mission of preparing the European charging infrastructure in a smart and interoperable way for the mass deployment of EVs. Time to fill in: approximately 10 – 15 minutes
Thank you very much in advance.

The SCALE team
www.scale-horizon.eu

Start of Block: 1) General

GDPR & privacy

○ **By ticking this box, you give your consent for the SCALE project to use your data for research purposes. All answers will be confidential and not shared with or sold to third parties, the data will be stocked in a secure way by Rupprecht Consult solely for and during the duration of the SCALE project (2022-2025). This survey is conducted in compliance with the European General Data Protection Regulation (GDPR). For further information,contact Shreesha Vaidhya (s.vaidhya@rupprecht-consult.eu)** (1)

B1 **1) General**

Q1 **What is the name of the DSO or TSO you work at?**

_____

_____

_____

_____

_____

Q2 **What is your position in your organization? What is your expertise?**

_____

_____

_____

Q3 **What is the population in the city or region?**

- ○ Less than 50 000 (1)
- ○ From 50 000 to 250 000 (2)
- ○ from 250 000 to 500.000 (3)
- ○ 500.000 - 1 million (4)
- ○ Over 1 million (5)
- ○ Don't know exactly (6)

Q4 **How would you describe EV deployment and charging infrastructure in your city or region?**

- ○ **Not developed** (very small proportion of EVs and a minimal charging infrastructure) (4)
- ○ **Starting up** (upcoming proportion of EVs and an expanding charging infrastructure) (5)
- ○ **Average** (an average proportion of EVs and average charging infrastructure for a European city/region) (6)
- ○ **Scale-up** (a high proportion of EVs and reliable coverage of charging infrastructure) (7)
- ○ **Pioneer in Europe/advanced** (a way above the average proportion of EVs and innovative charging infrastructure) (8)
- ○ **Differs per (sub) region** (9)

End of Block: 1) General

Start of Block: 2) Charging Strategies and Vision

B2 **2) Charging Strategies and Vision**

Q5 **Do the cities & regions in your distribution area have a strategy on how to get your electricity grid ready for the expected mass deployment of electric vehicles (EVs)?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub)region (4)
- ○ Don't know. (3)

Display This Question:

If Do the cities & regions in your distribution area have a strategy on how to get your electricity... = Yes.

Q6 **Do you rate that strategy/those strategies as sufficient in general for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

Display This Question:
If Do the cities & regions in your distribution area have a strategy on how to get your electricity... = No.

Q7 **Do you think this is needed for your area?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Don't know (3)

Q8 **Do you have prognoses for the growth of EVs in your distribution area?**

- ○ Yes (1)
- ○ No (2)
- ○ Differs per (sub)region (5)
- ○ Don't know (3)

Display This Question:
If Do you have prognoses for the growth of EVs in your distribution area? = Yes

Q9 **Do you rate your prognoses is sufficient for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

Display This Question:

If Do you have prognoses for the growth of EVs in your distribution area? = No

Q10 **Do you think this is needed for your area?**

- ○ Yes (1)
- ○ No (2)
- ○ Don't know (3)

Q11 **Is there a roll out plan for AC EV charge points in your area (destination charging)?**

- ○ Yes (1)
- ○ No (2)
- ○ Differs per (sub) region (4)
- ○ Don't know (3)

Display This Question:
If Is there a roll out plan for AC EV charge points in your area (destination charging)? = Yes

Q12 **Do you rate your AC roll out plan is sufficient for the future growth of EVs?**

- ○ Very Sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost Sufficient (4)
- ○ Not Sufficient (5)

Display This Question:
If Is there a roll out plan for AC EV charge points in your area (destination charging)? = No

Q13 **Do you think this is needed for your area?**

- ○ Yes (1)
- ○ No (3)
- ○ Don't know (4)

Q14 **Is there a roll out plan for DC EV charge points in your area (fast charging)?**

- ○ Yes (1)
- ○ No (2)
- ○ Varies per (sub) region (4)
- ○ Don't know (3)

Display This Question:

If Is there a roll out plan for DC EV charge points in your area (fast charging)? = Yes

Q15 **Do you rate your DC roll out plan is sufficient for the future growth of EVs?**

- ○ Very sufficient (1)
- ○ Sufficient (2)
- ○ Neutral (3)
- ○ Almost sufficient (4)
- ○ Not sufficient (5)

Display This Question:

If Is there a roll out plan for DC EV charge points in your area (fast charging)? = No

Q16 **Do you think this is needed for your area?**

- ○ Yes (1)
- ○ Varies per (sub) region (2)
- ○ No (3)
- ○ Don't know (4)

End of Block: 2) Charging Strategies and Vision

Start of Block: 3) Tendering processes for charging infrastructure

B3 **3) Tendering processes for charging infrastructure**

Q17 **Are you familiar with tendering processes for charging infrastructure?**

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Are you familiar with tendering processes for charging infrastructure? = No

Q18 **Who owns, operates and/or maintains public charging infrastructure in your region(s)?**

_____

_____

_____

_____

_____

Q19 **Who is financing the charging infrastructure in your area?**

_____

_____

_____

_____

_____

Q20 **Do the local or regional government in your area do procurement in regard to public charging?**

- ○ Yes (for which activities?) (1) _____
- ○ No (2)
- ○ Differs per region (3)
- ○ Don't know (4)

Q21 **Are there specific requirements regarding the charging infrastructure you actively advise or even demand in your area? 1/2**

Charging network-to-charging network interoperability (Enabling customers to use charging stations across different charging networks. Enabling them to start and stop charging via just one charge-pass/-id/-app) (1)	▼ Mandatory (1) ... Not Mandatory (3)
Smart charging (the speed and timing of charging electric cars can be adjusted using smart technologies. Charging can be at maximum rate most of the time and may be reduced or even stopped if there is a peak in the power demand, thus preventing overloading of the grid.) (2)	▼ Mandatory (1) ... Not Mandatory (3)
Vehicle to Grid (V2G) charging (One step further from 'smart charging' is even using the car to provide extra power to the grid when the demand is high (Vehicle to Grid/V2G). This way, we can ensure in the near future we will be charging millions of electric cars without any problems and in a sustainable manner.) (3)	▼ Mandatory (1) ... Not Mandatory (3)
Security measures (4)	▼ Mandatory (1) ... Not Mandatory (3)
Privacy measures (5)	▼ Mandatory (1) ... Not Mandatory (3)

Q22 **Are there specific requirements regarding the charging infrastructure that your city/region includes as a requirement in tenders? (2/2)**

	Yes (1)	No (2)	Don't know (3)
Smoot integration with electrical grid (Tell us more! [Optional]) (1)	○	○	○
Use of renewable energy (Tell us more! [Optional]) (2)	○	○	○
Other specific requirements (Tell us more! [Optional]) (3)	○	○	○

End of Block: 3) Tendering processes for charging infrastructure

Start of Block: 4) Predictions and roll-out plans

B4 **4) Predictions and roll-out plans**

Q23 **Does your city or region have up-to-date predictions for the growth of EVs in your area? (up-to-date in the sense that these predictions are usable for policy and planning.)**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub) region. (3)
- ○ Not sure. (4)

End of Block: 4) Predictions and roll-out plans

Start of Block: 5) Grid challenges

B5 **5) Grid challenges**

Q24 **Do you have an impact analysis for the electrical grid in your distribution area?**

- Yes. (1)
- No. (2)
- Differs per (sub) region (3)
- Not sure (4)

Display This Question:
If Do you have an impact analysis for the electrical grid in your distribution area? = Yes.

Q25 **Do you rate your impact analysis is sufficient for the eletricity grid to handle the expected future growth of EVs?**

- Very sufficient (1)
- Sufficient (2)
- Neutral (3)
- Almost sufficient (4)
- Not sufficient (5)

Display This Question:
If Do you have an impact analysis for the electrical grid in your distribution area? = Yes.

Q26 **What is de scope of that analysis?**

- 2025 (1)
- 2030 (2)
- 2050 (3)
- Other (4)

Display This Question:

If Do you have an impact analysis for the electrical grid in your distribution area? = No.

Q27 **Why not?**

- No need for in our opinion (1)
- No time invested in yet (2)
- No budget for it (3)
- Lack of cooperation with the local government (4)
- Lack of cooperation with the local government (5)
- Other: [please fill in: ….] (6) _____

Q28 **Is grid congestion currently a problem in your distribution area?**

- ○ No problem (1)
- ○ Slightly problematic (2)
- ○ Neutral (3)
- ○ Problematic (4)
- ○ Big problem here (5)

Q29 **Will electricity grid congestion become a larger problem in your city/area in the upcoming years?**

- ○ Yes, it already is (1)
- ○ Yes, in the short term (2 to 5 years) (2)
- ○ Yes, in the medium term (5 to 10 years) (3)
- ○ Yes, in the long term (beyond 10 years) (4)
- ○ No, I don't think so (6)
- ○ Don't know. (7)

Q30 **How do you value the cooperation between you as a DSO or TSO and the local government(s) in your area regarding electricity grid reinforcement?**

- ○ Very good (1)
- ○ Good (2)
- ○ Neutral (3)
- ○ Okay (4)
- ○ Not good (5)
- ○ Differs per (sub) region (6)
- ○ Don't know (7)

Display This Question:

If How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Very good

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Good

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Neutral

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Okay

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Not good

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Differs per (sub) region

And How do you value the cooperation between you as a DSO or TSO and the local government(s) in your... = Don't know

Q31 **Please elaborate your valuation:**

Q32 **Are the DSOs cooperating in a structural manner with the TSO on grid reinforcement in your area?**

- ○ Yes. (1)
- ○ No. (2)
- ○ Differs per (sub) region. (3)
- ○ Dont know. (4)

Display This Question:

If Are the DSOs cooperating in a structural manner with the TSO on grid reinforcement in your area? = Yes.

Q33 **How do you value the cooperation?**

- ○ Very good (1)
- ○ Good (2)
- ○ Neutral (3)
- ○ Okay (4)
- ○ Not good (5)

Display This Question:

If Are the DSOs cooperating in a structural manner with the TSO on grid reinforcement in your area? = No.

Q34 **Why not?**

_____

_____

_____

_____

_____

Q35 **Are you using or considering smart charging* or Vehicle-to-Grid^ (V2G) to balance tensions on the grid?**
* Dynamic charging based on EV Battery State of Charge (SoC), power availability, tariff, etc.
^ EV supplying back excess energy to the grid

- ○ Yes, smart charging is implemented (1)
- ○ Yes, smart charging and V2G are implemented (3)
- ○ Yes, smart charging is considered (5)
- ○ Yes, smart charging and V2G are considered (2)
- ○ No (6)
- ○ Don't know (7)

Display This Question:

If Are you using or considering smart charging or Vehicle-to-Grid^ (V2G) to balance tensions on the... = Yes, smart charging is implemented*

And Are you using or considering smart charging or Vehicle-to-Grid^ (V2G) to balance tensions on the... = Yes, smart charging and V2G are implemented*

And Are you using or considering smart charging or Vehicle-to-Grid^ (V2G) to balance tensions on the... = Yes, smart charging is considered*

And Are you using or considering smart charging or Vehicle-to-Grid^ (V2G) to balance tensions on the... = Yes, smart charging and V2G are considered*

Q36 **Please tell us more:**

_____

_____

_____

_____

_____

End of Block: 5) Grid challenges

Start of Block: 6) Testing of smart charging & Vehicle-2-Grid innovations

B6 **6) Testing of smart charging & Vehicle-2-Grid innovations**

Q37 **SCALE is testing use cases in four Innovation Clusters: Home Business/Office Light and Heavy duty Public for which smart charging and Vehicle-to-Grid (V2G) is either already playing a significant role or will become a necessity in the next years. Each use case will focus on a different aspect to ensure complementarity and range. Detailed information can be found on our website**

Are there EV Charging projects/demonstrations in your area which are relevant in this respect? Please tell us more and provide links to online information if possible/available:

_____

_____

_____

_____

_____

End of Block: 6) Testing of smart charging & Vehicle-2-Grid innovations

Start of Block: 7) Knowledge gaps & needs

B7 **7) Knowledge gaps & needs**

Q38 **On what subject are you lacking information or knowledge? (ticking multiple options is possible)**

- ☐ Location planning for EV charging stations (1)
- ☐ Predictions for EV charging demand per suburb (2)
- ☐ Predictions for grid constraints (3)
- ☐ Digital tooling for this subject (locations planning, grid constraints, etc). (4)
- ☐ Validated tender procedures for EV smart charging infrastructure (5)
- ☐ Validated tender procedures for Vehicle-to-Grid charging infrastructure (6)
- ☐ Information on different market models to consider in Tenders. (7)
- ☐ Information on hardware requirements for EV smart charging infrastructure (8)
- ☐ Information on software requirements for EV smart charging infrastructure (9)
- ☐ Information on hardware requirements for Vehicle-to-Grid charging infrastructure (10)
- ☐ Information on software requirements for Vehicle-to-Grid charging infrastructure (11)
- ☐ Defining the strategy on how to let grow the EV charging network (Strategic placement, demand-driven placement, data-based placement, etc.) (12)
- ☐ Other: (13) _____
- ☐ Not clear for me what we are lacking (14)
- ☐ I don't have a lack information or knowledge on this subject. If so, where do you get your information/knowledge from: (15) _____

End of Block: 7) Knowledge gaps & needs

Start of Block: 8) Interview?

B8 **8) Interview?**

Q39 **Thank you for your time and actively partaking in our survey! Can we approach you for a short interview (max 30 minutes, via videocall or phone) to dive deeper in your needs and challenges? If yes, please provide your e-mail address and/or phone number for the purpose of making an appointment for this interview:**

- ○ **E-mail address:** (1) _____
- ○ **Phone number:** (2) _____
- ○ **No, please do not approach me for this** (3)

Q40 **Are you interested in getting involved or staying updated on the project?**

Then you can: Join the movement by expressing your interests to be part of SCALE Reference Group/V2X Alliance/Joint Procurement Program and get an insider's perspective on SCALE's innovative work, direct access to our findings and connect with experts in the field of smart charging and bidirectional charging (V2G/V2X) Follow the SCALE LinkedIn Page to not miss any of the exciting developments happening in the project, to share your thoughts and take the conversation of smart charging and V2G/V2X ahead! Do you want to subscribe to the SCALE newsletter to get trimestral updates straight in your inbox?

Stay tuned for further updates!

- ○ **Yes, please!** (4)
- ○ **No, thank you.** (5)

End of Block: 8) Interview?

Start of Block: Block 8

B9 Thank you very much!

The SCALE team

www.scale-horizon.eu

Do you have feedback or want to let us know anything else?

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_____

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_____

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End of Block: Block 8