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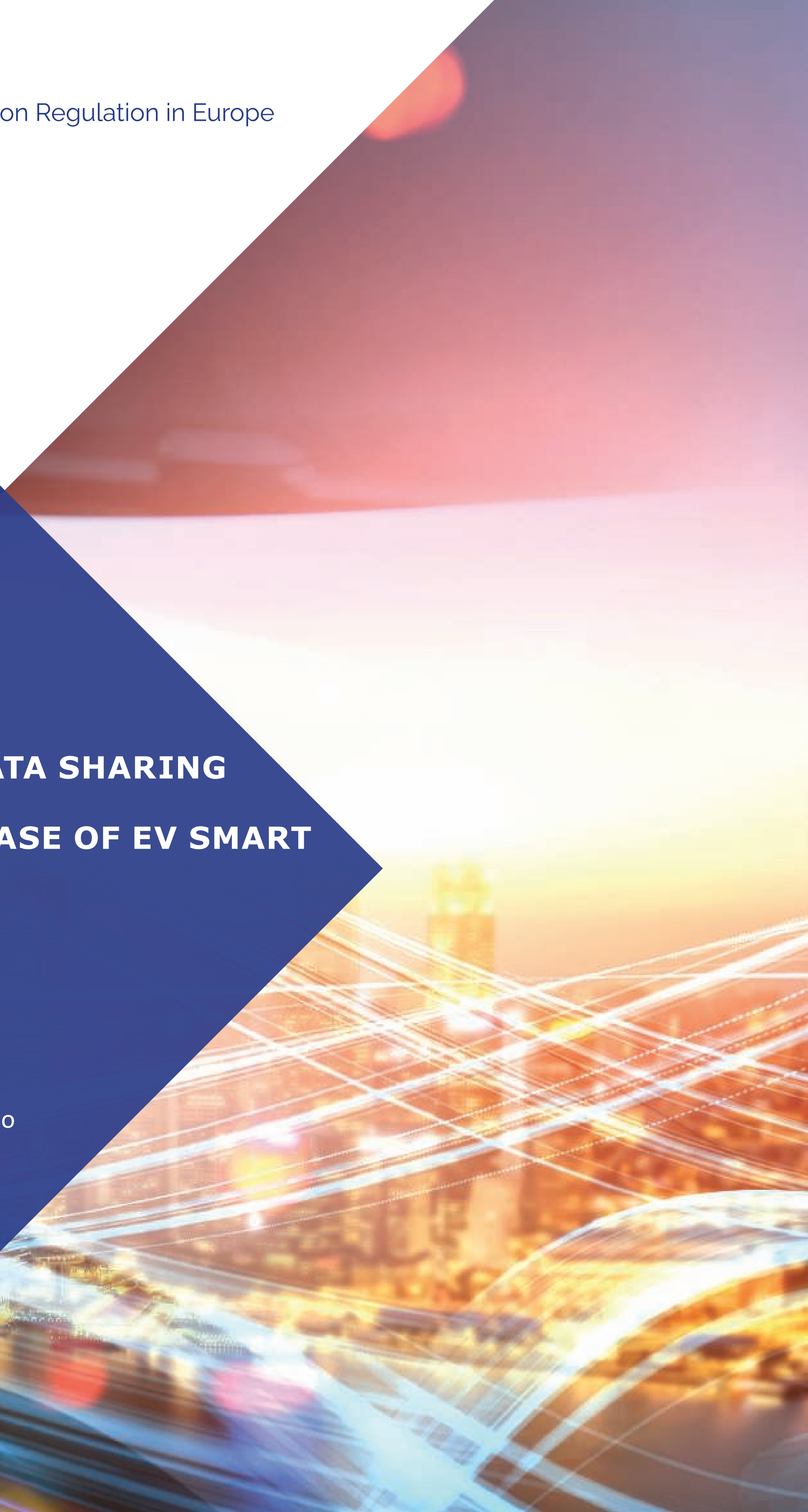

ENERGY DATA SHARING AND THE CASE OF EV SMART CHARGING

REPORT

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His primary research interests are related to innovation policy, intellectual property, competition policy, market regulation, and economic analysis of law.

LIST OF ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators
AFIR	Alternative Fuels Infrastructure Regulation
API	Application Programming Interface
DMA	Digital Markets Act
DSOs	Distribution System Operators
EHDS	European Health Data Space
ENTSO-E	European Network of Transmission System Operators for Electricity
EPBD	Energy Performance of Buildings Directive
EU	European Union
EV	Electric Vehicle
FHWA	Federal Highway Administration
GDPR	General Data Protection Regulation
GW	Gigawatt
ICT	Information and Communications Technology
IoT	Internet of Things
NCCS	Network Code on Cybersecurity of Cross-Border Electricity Flows
NEVI	National Electric Vehicle Infrastructure
NIS2	Directive on Security of Network and Information Systems
PSD2	Second Payment Service Directive
PV	Photovoltaic
RED	Renewable Energy Directive
TSOs	Transmission System Operators
V2G	Vehicle-to-Grid

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EXECUTIVE SUMMARY

The rollout of charging infrastructure for battery-powered vehicles is critical to meet the European Union's (EU) ambitious energy transition. Although the European Commission is currently suggesting several regulatory options and state support schemes to favour the roll out of charge points, the data sharing aspect of the issue remains largely unaddressed and unexplored. Yet, **data sharing frameworks are key in the realisation of smart charging initiatives**, as they provide guidelines and protocols to ensure that stakeholders can share data securely and seamlessly.

Against this background, this report examines the potential impacts of data sharing related to electric vehicle battery charging and electricity provision. The report arrives at a moment of regulatory ambiguity in the EU over the nature of data sharing that will be involved in this industry and whether there will be EU rules or national rules that **ensure choice and prevent data monopolisation**. Resolving the ambiguity is important due to the potentially decisive role that car batteries can ultimately play in storing variable renewable energy, like wind and solar, and returning this energy to the network at times of demand. The role of bi-directional **charging** can create a positive externality by reducing greenhouse gas provision both related to transport and electricity production.

We first describe the differences between unidirectional and bidirectional smart charging to point out their respective data needs and the related data-governed transactions. Notably, **bidirectional smart charging** would add an important element to energy systems by allowing the battery to feed energy into the system as a distributed producer. The paper proceeds by considering the broad economic features of bi-directional charging technology that is possible with car batteries. The technology allows them both to draw energy from the network at times of low cost (relative abundance) and to contribute energy to the network, at times of high energy value (relative scarcity). Such arbitrage could help to resolve the primary challenges related to renewables, concerning **reliability and predictability** of energy supply.

The paper then examines the broad **regulatory framework on data sharing in the EU**, showing how this framework is supplemented by energy specific data requirements. We maintain that the main regulatory challenges are represented by the policy choices related to **interoperability and standardisation**, in particular the option for a mandated rather than a facilitated API adoption, and the concerns about **privacy and cybersecurity**. To illustrate potential data-related solutions for smart charging, both the **UK and the US experiences** are investigated. With regards to the former, the Competition and Markets Authority explicitly referred to the Open Banking as a blueprint to fully maximise the benefits of smart charging, hence recommending the Government to set open data and software standards. The relevance of defining common and open API standards, data formats, and security protocols is shared by the US initiative to build out a national EV charging network. To this aim, it has been proposed to establish regulations setting minimum standards regarding, amonge other things, the interoperability of charging infrastructure, the network connectivity of charging infrastructure, and the information on publicly-available charging infrastructure locations, pricing, real-time availability, and accessibility through mapping applications.

A key point that is suggested in the study is that, while the EU may have a debate over whether to establish requirements for data sharing, **failure to require openness at an early stage is not likely to**

be counteracted by high customer demand for openness and could create lock-in for car customers to “mini” monopolies. Openness does not require imposition of one standard: openness only implies **open access to each standard and information held** under that standard.

The report draws **five broad recommendations**:

1. Require **car manufacturers to adopt open and portable standards** for battery charging and electricity supply with functions available to any third parties chosen by the customer.
2. Ensure that **customers with no reasonable alternative are not locked by data systems** into purchasing energy from a charger at rates that are not competitive for either charging or selling of energy.
3. Ensure that **privacy safeguards are in place** to protect consumer information about their movements (and that these are not displaced by open data requirements).
4. Ensure that sufficient **transactional standards** are in place so that energy payments are secure.
5. **Avoid imposing obligations to suppliers to buy from EVs**. Thus, EVs would compete with other sources of energy and would not be guaranteed to provide energy when the economic conditions were not desirable nor be guaranteed prices above the market rate.

In some places, the prioritisation of renewable energy sources may previously have led to waste of government or end-customer funds and excessive rates of return for investors, which is one reason to be careful about imposing purchase obligations and prioritisation of purchase obligations on electricity suppliers.

1. INTRODUCTION

The green and digital transitions are concomitantly underway. There is potential for them to yield synergies with each other as Europe moves towards a smart, integrated, and cleaner energy system. Such a revised system could be based on variable and more distributed generation and greater electrification. Digital technologies can provide system optimisation and substantial operational/network infrastructure efficiency, support energy system integration, and help optimising the use of the existing grid capacity.

Electricity networks already include substantial dynamic updating and data movement for the purpose of engaging in transactional decisions over energy production, supply and, sometimes, usage. However, the small customer retail interface has remained relatively passive, as has the retail customer usage responsiveness to price, even with the introduction of small-scale "distributed" generation (such as home-based photovoltaic (PV) cells) and with "smart" meters that, in many implementations, have been relatively dumb.[1]

In its "***Action Plan on Digitalisation of Energy***", the European Commission aims to outline how EU policies and funding instruments can exploit the benefits of digital solutions in the energy sector, while minimising their risks and environmental footprint[2]. It will focus on five areas:

- Developing a **European data-sharing infrastructure** and a common European **energy data space** (compatible with other data spaces) to foster the development of an interoperability framework. This is to create a competitive market for energy services that supports planning and monitoring of energy infrastructure as well as demand-side flexibility;
- **Empowering European citizens** with tools for participation in energy markets as well as data-driven services and re/upskilling initiatives. It will seek to learn and promote best practices from research and innovation projects that developed new tools that make it easy for citizens to grant access to their data and become active players of the transition;
- **Driving the general uptake of digital tech** in energy by fostering research, innovation and supporting the scaling up of successful pilots (including for energy communities);
- **Improving the cybersecurity** of the sector with a mix of legacy tech with smart tech, in alignment with the overarching cybersecurity framework, specifically the revised Directive on Security of Network and Information Systems (NIS2) and the planned Network Code on cybersecurity of cross-border electricity flows (NCCS);
- Supporting the **development and uptake of climate-neutral solutions** for Information and Communications Technology (ICT). This is to complement the European Digital Strategy[3] and promote cooperation between the energy and digital sectors.

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[1] The UK's SMETS1 rollout could be cited as an example.

[2] European Commission, 'Roadmap to the Action Plan on the Digitalisation of the Energy Sector', (2021) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13141-Digitalising-the-energy-sector-EU-action-plan_en.

[3] European Commission, 'European Commission Digital Strategy' C(2018) 7118 final, 21 November, 2018.

The European Commission aims to develop a digital-driven "European energy data space" to allow for and support data sharing and system integration between the energy sector and other sectors, e.g. mobility. The sharing of such data, along with the general uptake of digital tools, will be critical in empowering EU citizens and giving them a more active role in the energy transition and system.

The Commission has recently unveiled the **Data Act**[4], which contains some high-level principles on data sharing across sectors, supplementing the Data Governance Regulation.[5] At the same time, stakeholders such as consumer organisation BEUC[6], have been calling the European Commission to go further and propose sector-specific rules. Also of relevance, the European Commission is reportedly planning to propose **sector-specific legislation for access to car data** in Q4 2022[7].

With respect to data and energy, other EU legislative proposals will also have relevance, such as the **NIS2**[8] and elements of the **Fit for 55** package[9] such as the **Alternative Fuels Infrastructure Regulation** (AFIR, repealing a previous Directive)[10], and the revised **Energy Performance of Buildings Directive** (EPBD)[11] and **Renewable Energy Directive** (RED).[12]

In this context, it is critical to identify the **business case to encourage industry players and customers to share their data, as well as the key governance principles for the sharing of such data**. Following a bottom-up approach, industry players and national regulators have a key role to play in laying out the bases of this framework.

CERRE is beginning its work at the intersection of data and energy with a paper focused on smart charging points. Their successful rollout is critical for the EU's energy transition. A dense and smart charging point network will not only help with the electrification of mobility but also with providing flexibility on when electricity is demanded for charging. Furthermore, the potential for vehicle batteries to serve as an energy storage medium means they can store energy at times of particularly high production, due to renewable variability, and contribute energy back to the network at times of scarcity. The European Commission is currently suggesting a number of regulatory options and state

[4] European Commission, 'Proposal for a Regulation on harmonised rules on fair access to and use of data (Data Act)', COM (2022) 68 final. For a comment, see Giuseppe Colangelo, 'European Proposal for a Data Act: A First Assessment', (2022) https://cerre.eu/publications/european-proposal-for-a-data-act-a-first-assessment/.

[5] Regulation (EU) 2022/868 on European data governance (Data Governance Act) [2022] OJ L 152/1.

[6] The acronym stands for Bureau Européen des Unions de Consommateurs. See letter of 31 January 2022 to Thierry Breton, BEUC ref. BEUC-X-2022-009/MGO/rs, https://www.beuc.eu/sites/default/files/publications/beuc-x-2022-009_action_to_protect_consumers_data_in_the_automotive_sector.pdf.

[7] See, e.g., https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13180-Access-to-vehicle-data-functions-and-resources_en.

[8] Proposal for a Directive on measures for a high common level of cybersecurity across the Union, repealing Directive (EU) 2016/1148, COM(2020) 823 final. In May 2022, the Council and the European Parliament reached an agreement on the final version of the Directive (https://www.consilium.europa.eu/en/press/press-releases/2022/05/13/renforcer-la-cybersecurite-et-la-resilience-a-l-echelle-de-l-ue-accord-provisoire-du-conseil-et-du-parlement-europeen/?utm_source=dsms-auto&utm_medium=email&utm_campaign=Strengthening+EU-wide+cybersecurity+and+resilience+%u2013+provisional+agreement+by+the+Council+and+the+European+Parliament).

[9] European Commission, 'European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions', (2021) https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541.

[10] Proposal for a Regulation on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU, COM(2021) 559 final.

[11] Proposal for a Directive on the energy performance of buildings (recast), COM(2021) 802 final.

[12] Proposal for a Directive amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652, COM(2021) 557 final.

support schemes to favour the roll out of charging points, but the data sharing aspect of the issue remains largely unaddressed and unexplored.[13]

In this context, the authors aims to identify guiding principles and recommendations to the European Commission and other relevant stakeholders related to data sharing and smart charging. Their contribution aims to feed into the discussions linked to the Action Plan on Digitalisation of Energy and sectoral initiatives following on from the Data Governance Regulation and the Data Act.

[13] See, for example, the Guiding template: Electric recharging stations and hydrogen stations for road vehicles, https://ec.europa.eu/competition/state_aid/what_is_new/template_RFF_electric_and_hydrogen_charging_stations.pdf.

2. SMART CHARGING AND ITS DATA NEEDS

As the rollout of charging infrastructure for battery-powered vehicles expands, with an expected rapid increase in this rollout in the years ahead in order to meet the ambitious transport energy rebalancing promised by 2030 in Europe, the possibility arises of adding unidirectional and bidirectional smart charging.[14] These expansion possibilities are not simply theoretical, as in 2021, 17% of car sales were electric vehicles (EVs).[15] A number of demonstration projects have been undertaken. In **unidirectional smart charging**, the EV extracts electricity from the network at rates and times that are coordinated via the use of digital planning in "communication" between the battery charger and energy providers. The data can be exchanged through different channels, such as an app, the charging station, or over the air. This data-governed transaction would include information on the battery (including state of charge, power setpoint and capacity), the user needs (including priority of charging compared to ability to wait, pricing for different times of download and potentially dynamic battery charging depending on exact network balancing needs and prices as they evolve over time), charging location and ownership and pricing structure of the charging point. If 50 million EVs are on the road within a decade, that could represent 3,500 GWh of storage capacity.[16] This is between 2 to 3 times the size of all the hydraulic storage capacities in Europe.[17]

Given that typical vehicles are parked 95% of the time[18], **bidirectional smart charging** would add an important further element to the system, by allowing the battery to feed energy into the system as a distributed producer. That is, a battery can be treated as a source of energy to the system, even if much lower in output than an electricity plant. Regulators are increasingly recognising the value of bidirectional charging for energy systems, with the French transmission system operator RTE having certified bidirectional charging as a mature technology that can be used on the grid.[19] Specifically, EV batteries can play into the electricity network as devices that are able to charge at times of high supply capacity and low-cost production, including when RES would otherwise be curtailed due to lack of demand, and then cease their charging in order to meet system balancing needs and ultimately contribute energy to the network at times of production scarcity and high price production. EV batteries can perform arbitrage, and yield their owners, operators or intermediaries an arbitrage profit that could help lower the effective cost of car batteries.[20]

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[14] See European Commission, 'Best practices and assessment of regulatory measures for cost-efficient integration of electric vehicles into the electricity grid', (2022) https://op.europa.eu/en/publication-detail/-/publication/d877544f-8a23-11ec-8c40-01aa75ed71a1/language-en

[15] See IEA (2022) 'Electric cars fend off supply challenges to more than double global sales', https://www.iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales

[16] See Jean-Philippe Laurent, 'Towards the mass adoption of smart and bidirectional charging, the key contribution of the "Fit for 55" package', (2022) Euractiv, https://www.euractiv.com/section/transport/opinion/towards-the-mass-adoption-of-smart-and-bidirectional-charging-the-key-contribution-of-the-fit-for-55-package/

[17] Hydraulic storage is currently the only competitive way to "store" electricity and, like batteries, can be turned on instantly, whether for storage or generation (see Laurent, supra note 16).

[18] See, for example, BBC (2018) 'Why you have (probably) bought your last car', https://www.bbc.com/news/business-45786690.

[19] https://assets.rte-france.com/prod/public/2022-02/CP_vehicules%20electriques_RTE_Dreev_V2G.pdf

[20] See Stephan Meisel and Tanja Merfeld, 'Economic incentives for the adoption of electric vehicles: A classification and review of e-vehicle services', 65 Transportation Research Part D 264 (2018), for characterisation of different economic uses of demand supply from EV batteries which can also serve as one of the consideration in lowering the cost of vehicles and increasing their rollout.

The introduction of unidirectional and bidirectional smart charging can deliver more efficiency. Having said that, in some networks, implementing more smart charging could require infrastructure system upgrades to handle local variability in demand and supply, as well as to cover higher overall electricity usage, though this may vary by country.[21] These costs are not taken directly into account in the costs of charging stations but will need to be borne and shared out across system users.[22] Part of the communication cost of bidirectional smart charging may be borne outside the direct relationship between the electricity supplier, electricity buyer and battery "manager". The willingness to enter contracts and manage the relationship will influence the types of contracts that are possible.[23]

Transactions involving either unidirectional or bi-directional smart charging can potentially result in different "sellers" of electricity operating over the same infrastructure, along with different "buyers" while such a distributed development would create system management challenges when total volumes become large relative to local load. With respect to charging EVs, the buyers can be both car batteries or aggregators who buy from car batteries (or who reduce their consumption on demand of system operators). At different times of day, the buyers could become sellers. One can imagine that apps over smartphones or car-based wireless would generate the orders to the system for smart bidirectional charging, depending on system conditions and prices for various aspects of the system, including the charging station. This requires secure communications to cars from distant controllers, and secure connections between charging stations and vehicles for the movement and monitoring of electricity "download" and "upload."

The parties involved in transactions can potentially include electricity distributors, electricity retailers, electricity flexibility operators, car users, car owners (in case of rental cars), car manufacturers, battery manufacturers, and battery charging station owners from both private and public spheres, telecom networks, data networks on top of wireless or wireline networks, app owners and others. This list illustrates the variety of potential market participants. The types of contracts that will eventually evolve in the market will likely depend on who is best placed to supply electricity, buy electricity and arbitrage electricity. The extent of data sharing and interoperability of data networks with each other is likely to impact the ultimate efficiency of the system.[24]

The economic use case for batteries could depend further on the number of **optimum charging cycles** for batteries, which typically have a limited number of cycles of recharging before they must be

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[21] While some infrastructure improvement is required under the Energy Performance of Buildings Directive, it contains no smart charging requirement. See Andrea Mangipinto, Francesco Lombardi, Francesco Davide Sanvito, Matija Pavičević, Sylvain Quoilin, and Emanuela Colombo, 'Impact of mass-scale deployment of electric vehicles and benefits of smart charging across all European countries', 312 Applied Energy 118676 (2022). The French RTE, the NSO, and Enedys, the DSO, for example, have determined that France's network will remain stable even with large scale smart charging.

[22] ENTSOE, 'Electric Vehicle Integration into Power Grid' (2021) https://www.entsoe.eu/2021/04/02/electric-vehicle-integration-into-power-grids/ .

[23] See Bing Haung, Aart Gerard Meijssen, Jan Anne Annema, and Zofia Lukszo, 'Are electric vehicle drivers willing to participate in vehicle-to-grid contracts? A context-dependent stated choice experiment', 156 Energy Policy 112410 (2021).

[24] For a discussion of initial points on how smart charging factors may integrate with data concerns, see EV Energy Taskforce, 'Data Accessibility and Privacy', (2021) https://evenergytaskforce.com/reports/phase-two-working-group-4/; Id., 'Engaging EV Users in Smart Charging and Energy Services', (2021) https://evenergytaskforce.com/reports/phase-two-working-group-2/; Id., 'Cyber Security and Smart Charging', (2021) https://evenergytaskforce.com/reports/phase-two-working-group-3/; and Id., 'Accessible Data for Decision Making', (2020) https://evenergytaskforce.com/reports/work-package-four/.

replaced. With current EV batteries, the battery life will typically be longer than the transport use case for the batteries, so that many cycles can be given over to smart charging without sacrificing the core transport value of the battery. If the number of charging cycles designed into batteries falls substantially in the future, given the large cost of new batteries, increasing the number of cycles used for delivering energy into the network would require that charging at low-cost moments and providing energy to the network at high-cost moments must have a margin for the battery operator that exceeds any efficiency loss from storage and the reduced battery lifetime from each cycle of charging and emptying of a battery. This point is more related to future designs than current ones that, with a lifetime of 1,000 cycles, are unlikely to decrease their transport effective life because of the use in bi-directional smart charging. In practice, car manufacturers will define physical constraints such as "State of Charge" and cycling limits to avoid battery degradation and to keep the battery warranty.[25]

Yet **lack of interoperability**, from differing standards, limits user choice about where to charge and how to pay, and prevents users from benefitting from the diversity of smart charging services available in the market. If car charging stations are, like petrol stations, the unique deciders of the charging that happens over their infrastructure, this will create a limited regime for charging while ensuring high incentives for construction and may create localised market power that results in less return on the EV investment. On the other hand, if car charging stations are organised more like ATMs, with multiple suppliers and user combinations able to access the infrastructure, potentially at a price, the profits from constructing the charging stations might be lower, so investment incentives would be lower, but opportunities for arbitrage by battery owners might be increased and give them more incentives to invest in EV. A widescale charging network in Europe will have chargers at homes, on street parking, at workplaces and along roads.

The breadth of possible contracting relationships is enormous due to the wide range of actors actually and potentially involved in EV charging. Simplifying the possibilities to some extent, we later elaborate (in Section 5) on four core scenarios that characterise potential customer (car owner and operator) relationships with the activity of buying and supplying electricity. These range from using cars as a supply of micro-generation to having contracts directly between car owners and energy networks, intermediaries, or limited to car battery manufacturers, with the latter illustrating a potential "closed" system that constrains car owner choice over its contracting partners.

Given the complex and varied interests of involved parties, the models that govern the system will likely differ from one country to another and evolve over time in varied responses to reflect differing incentives of different players. Flexibility in ultimate modes of operation is thus crucial to build into the system during its early growth. **Criteria for successful use of information** will include ensuring that:

- Information provided in one format can be read by all other users eligible to access the data;
- Information required for energy optimisation is sent by the vehicle to other parties legitimately linked to the battery recharging process;

[25] Vehicle to grid (V2G) operators will be able to perform up to 100 V2G cycles per year within the 20% to 80% charging range of batteries.

- Smart charging data and vehicle-to-grid functionality is accessible to any third party upon final customer decision;
- Energy sources that are viable are given an incentive to produce as long as storage is expected to be profitable;
- Profitable storage is incentivised to occur and for batteries to be purchased; and
- Battery charging stations earn a sufficient return to also be incentivised to build out in line with expected future demand.

Energy from a battery can potentially be used at home, used in a building or used in the grid. The opportunity of rolling out smart charging is high. Grid stability seems high in many countries and resistant to large scale battery charging, with the time variable part of smart charging being quite important to guarantee this result across countries.[26] To provide the right incentives for rollout, innovation at the grid level, charging station level, battery level and customer level must all interact to complement each other and align interests, otherwise socially desirable innovations will not be made.[27] Nonetheless, conflicts of interest will remain with different types of entity seeking to maintain suitable return on investment along with access to the new profit streams.

[26] One study suggests that uncontrolled charging by a fleet of EV cars that is of substantial size (e.g., 50% of the fleet) could lead to grid instability and voltage variation. See H. Li and X. Bai, 'Impacts of electric vehicle charging on the electricity grid', (2011) https://www.researchgate.net/publication/297055070_Impacts_of_electric_vehicles_charging_on_distribution_grid.

[27] See Ernst & Young and Eurelectric, 'Power sector accelerating e-mobility: Can utilities turn EVs into a grid asset?', (2021) https://www.eurelectric.org/media/5704/power_sector_accelerating_e-mobility-2022_eyeurelectric_report-2022-030-0059-01-e.pdf; and David Deller, Thanh Doan, and Franco Mariuzzo with Sean Ennis, Amelia Fletcher and Peter Ormosi, 'Competition and innovation in digital markets', BEIS Working Paper No. 40 (2021), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003985/uae-ccp-report__1_.pdf.

3. EUROPEAN DATA SHARING REGIMES

Given that cars and charging stations share data when a car is charging, data sharing frameworks are key in the realisation of smart charging initiatives, as they provide guidelines and protocols to ensure that stakeholders can share data securely and seamlessly.

In the last years, on the premise that the value of data lies in its use and re-use, access to data and related data sharing practices has gained prominent attention among policymakers as a crucial factor in unlocking competition and enabling innovation to flourish. The European Union has been a forerunner in promoting the free flows of data with a broad array of heterogeneous legislative initiatives, many of them aimed to empower digital consumers making them conscious decision-makers in digital markets.[28]

Notably, the **General Data Protection Regulation** (GDPR) enshrined a general data portability right for individuals[29]; the **Second Payment Service Directive** (PSD2) introduced a rule on sector-specific access to account data[30]; the **Regulation on the free-flow of non-personal data** encouraged the development of self-regulatory codes of conduct to facilitate data sharing practices in business-to-business relationships[31]; the **Open Data Directive** aimed at promoting government-to-business data sharing collaboration supporting the wide availability and re-use of public sector information for private or commercial purposes[32]; and the **Data Governance Act** aimed at increasing trust in sharing data, lower transaction costs linked to business-to-business and consumer-to-business data sharing, and harmonise conditions for the use of certain public sector data.[33] Moreover, the strategic role played by large platform-based digital ecosystems, the growing relevance of the Internet of Things (IoT), and concerns about user lock-in prompted the European institutions to introduce interoperability obligations in the recently approved **Digital Markets Act** (DMA)[34] and in the proposal for a **Data Act**.[35]

These data-related legislative initiatives significantly differ among themselves in terms of scope and approach. Some interventions are horizontal (i.e., cross-sector), others are sector-specific; some mandate data sharing, others envisage measures to facilitate the voluntary sharing; some introduce general data rights, others allow asymmetric data access rights. However, they share one essential

[28] Giuseppe Colangelo and Mariateresa Maggiolino, 'From fragile to smart consumers: shifting paradigm for the digital era', 35 Computer Law & Security Review 173 (2019). For an overview of the European initiatives, see European Commission, Commission Staff Working Document on 'Common European Data Spaces', SWD(2022) 45 final.

[29] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC [2016] OJ L 119/1, Article 20.

[30] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC, [2015] OJ L 337/35, Article 67.

[31] Regulation (EU) 2018/1807 of the European Parliament and of the Council of 14 November 2018 on a framework for the free flow of non-personal data in the European Union, [2018] OJ L 303/59.

[32] Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information, [2019] OJ L 172/56.

[33] Data Governance Act, supra note 5.

[34] Regulation (EU) 2022/1925 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act), (2022) OJ L 265/1.

[35] Data Act, supra note 4. See Oscar Borgogno and Giuseppe Colangelo, 'Shaping interoperability for the IoT: the case for ecosystem-tailored standardisation', (2022) Deep-In Working Paper, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4106894.

technical feature, namely the strong reliance on **Application Programming Interfaces (APIs) as a key enabler** to ensure a sound and effective data sharing ecosystem.[36]

Moreover, with regard to the sharing regime, we are witnessing a progressive shift towards interoperability. In the European data strategy, to overcome legal and technical barriers to data sharing, the European Commission indeed announced the establishment of EU-wide common, **interoperable data spaces** in strategic sectors (including mobility and energy), which should foster an ecosystem of companies, civil society, and individuals creating new products and services based on more accessible data.[37] In particular, the European Commission has identified the lack of interoperability as a crucial element for the exploitation of data value, especially in the context of artificial intelligence deployment. In this context, the European Data Innovation Board, proposed by the Data Governance Act, will support the European Commission in identifying the relevant standards and interoperability requirements for cross-sector data sharing.

The key role of interoperability has been confirmed in the recent launch of the proposal for a **European Health Data Space** (EHDS), the first common data space in a specific area to emerge from the EU strategy for data.[38] Given that a substantial amount of electronic data to be accessed in the EHDS are personal health data, the proposal supports the implementation of the portability right enshrined in the GDPR as applied to electronic health data while, with regards to the secondary use of electronic health data, it builds upon and complements the Data Governance Act and the proposed Data Act. Accordingly, although natural persons will have additional possibilities to digitally access and transmit their electronic health data building upon provisions in the GDPR, market operators will be obliged to share electronic health data with user-selected third parties from the health sector.

For the sake of our analysis, the Data Act requires further attention as it sets horizontal principles for all sectors and covers business-to-consumers and business-to-business relationships, personal and non-personal data. Vehicles are explicitly included in its scope as physical products that obtain, generate or collect data concerning their performance, use or environment and that can communicate that data via a publicly available electronic communications service. The Data Act moves from the premise that the manufacturer/designer of a product or related service typically has exclusive control over the use of data generated using a product or related service. This contributes to users' lock-in effects and hinders market entry for players offering aftermarket services and novel services (so-called **vendor lock-in**). To address this problem, the Data Act envisages a cross-sectoral governance framework to ensure that products are designed and manufactured, and related services are provided in such a manner that data generated by their use are easily accessible to the user. Notably, while users of IoT products and related services are empowered with new access and use rights, as well as a right to share the generated data with third parties, manufacturers and designers on the other hand are required to design products in a way that makes the data directly accessible by default or, where data cannot be directly accessed from the product, makes available the data generated promptly and free of charge to users.

[36] Oscar Borgogno and Giuseppe Colangelo, 'Data sharing and interoperability: Fostering innovation and competition through APIs', 35 Computer Law & Security Review 105314 (2019).
[37] European Commission, 'A European strategy for data', COM(2020) 66 final, 16.
[38] European Commission, 'Proposal for a Regulation on the European Health Data Space', COM(2022) 197 final.

A policy intervention on EV smart charging may share with the Data Act the goal to avoid *de facto* exclusivity control over data enjoyed by manufacturers of devices.

In general, the relationship between interoperability and digital markets is controversial. On the one side, because of the economic features of digital markets interoperability may be seen as the needed solution to ensure an effective data sharing and promote technological innovation. Notably, digital ecosystems have surfaced as infrastructures within which a huge number of IoT interactions take place and few players enjoy a gatekeeping position, which allows them to restrain other firms' ability to benefit from network effects and obtain unchallenged access to data. The ability to gather and access different data sources is instead crucial for IoT innovation to thrive as the rapid adoption of IoT is possible if all sorts of devices can be interconnected and can exchange data in real time. However, on the other side, interoperability may be questioned as the solution to this problem because it runs counter to the fundamental economics of these markets that favour concentration.

Against this background, the pro-competition goal underpinning the right to data portability enshrined within the GDPR probably led to misguided expectations since, due to the presence of strong network effects, mitigating switching costs through mere data portability has proven to be insufficient in promoting multi-homing and easing data-induced lock-in effects. Rather, concerns have been raised about the unintended effects of the provision in terms of competition and innovation as it may have entrenched the market power of incumbents and negatively affected firms seeking data to develop new products.[39] Further, in markets featuring strong network effects, even when data portability allows users to multi-home, the dominant position of must-have services may remain unchallenged and the elimination of switching costs may even cause the market to tip into a monopoly situation.[40]

On these premises, the proposal to rely on an ***in situ* data right** for both individuals and firms has been put forward, which implies that rather than moving data from the platform, users are allowed to use their data in the location where they reside and to determine when and under what conditions third parties can access their *in situ* data.[41] In the European scenario, the access-to-account rule enshrined in the PSD2 represents an early case of *in situ* data right.[42]

Finally, it cannot be overlooked that building trust, avoiding data breaches, and ensuring cybersecurity are essential elements in facilitating data sharing. A secure and privacy-preserving infrastructure to pool, access, share, process and use data represents a key feature of a common European data

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[39] See, e.g., Chinchih Chen, Carl Benedikt Frey, and Giorgio Presidente, 'Privacy Regulation and Firm Performance: Estimating the GDPR Effect Globally', Oxford Martin School Working Paper No. 1 (2022), https://www.oxfordmartin.ox.ac.uk/downloads/Privacy-Regulation-and-Firm-Performance-Giorgio-WP-Upload-2022-1.pdf; Rebecca Janßen, Reinhold Kesler, Michael E. Kummer, and Joel Waldfogel, 'GDPR and the Lost Generation of Innovative Apps', NBER Working Paper No. 30028 (2022), https://www.nber.org/papers/w30028; Garrett Johnson, Scott Shriver, and Samuel Goldberg, 'Privacy & Market Concentration: Intended & Unintended Consequences of the GDPR', (2022) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3477686; Christian Peukert, Stefan Bechtold, Michail Batikas, and Tobias Kretschemer, 'Regulatory Spillovers and Data Governance: Evidence from the GDPR', (forthcoming) Marketing Science; Michal Gal and Oshrit Aviv, 'The Unintended Competitive Effects of the GDPR', 16 Journal of Competition Law and Economics 349 (2020); Wing M.W. Lam and Xingyi Liu, 'Does Data Portability Facilitate Entry?', 69 International Journal of Industrial Organization 102564 (2020).

[40] Jan Krämer, Pierre Senellart, and Alexandre de Streel, 'Making data Portability More Effective for The Digital Economy', (2020) CERRE Report ttps://cerre.eu/publications/report-making-data-portability-more-effective-digital-economy/.

[41] Bertin Martens, Geoffrey Parker, Georgios Petropoulos, and Marshall van Alstyne, 'Towards Efficient Information Sharing in Network Markets', Bruegel Working Paper No. 12 (2021), https://www.bruegel.org/2021/11/towards-efficient-information-sharing-in-network-markets/.

[42] Oscar Borgogno and Giuseppe Colangelo, 'Data, Innovation and Competition in Finance: The Case of the Access to Account Rule', 31 European Business Law Review 573 (2020).

space.[43] Therefore, the common technical infrastructure must integrate the cybersecurity-by-design principle and respect the data protection by design and by default obligations enshrined in the GDPR.[44] As we will see in the next section, privacy and cybersecurity issues play an even more relevant role in the energy sector.

3.1 Energy-specific data sharing regimes

The development of charging infrastructure for EVs has already been addressed in the 2014 **Deployment of Alternative Fuels Infrastructure Directive**, which established a common framework of measures for the deployment of alternative fuels infrastructure to minimise dependence on oil and to mitigate the environmental impact of transport.[45] For that occasion, the EU legislator maintained that "the recharging of electric vehicles at recharging points should make use of intelligent metering systems in order to contribute to the stability of the electricity system by recharging batteries from the grid at times of low general electricity demand and to allow secure and flexible data handling. In the long term, this may also enable electric vehicles to feed power from the batteries back into the grid at times of high general electricity demand."[46] However, the Directive did not outline smart charging or vehicle-to-grid (V2G) and its electricity system integration.

More recently, data access and sharing obligations have also been envisaged to address specific issues in the electricity sector. In particular, while the **Regulation 2017/1485** has introduced data-sharing obligations for electricity network operators to ensure system security[47], the **Electricity Directive** has requested Member States to ensure the deployment of smart metering systems which should be interoperable, in particular with consumer energy management systems and with smart grids.[48] To assist consumers' active participation, smart metering systems that are deployed should be equipped with fit-for-purpose functionalities that allow consumers to: i) have near real-time access to their consumption data; ii) modulate their energy consumption; iii) offer their flexibility to the network and to electricity undertakings; and iv) be rewarded for it.

Moreover, the proposed revision of the **RED** introduces measures addressing the need for real-time access to basic battery information (such as state of health, state of charge, capacity and power set point) for facilitating the integration-related operations of domestic batteries and electric vehicles.[49] Notably, Member States are required to ensure that manufacturers of domestic and industrial batteries enable real-time access to basic battery management system information to battery owners and users as well as to third parties acting on their behalf, under non-discriminatory terms and at no cost. Further, Member States shall ensure that vehicle manufacturers make available, in real-time, in-

[43] European Commission, supra note 25, 2.
[44] Ibid., 4.
[45] Directive (EU) 2014/94 of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure, [2014] OJ L 307/1.
[46] Ibid., Recital 28.
[47] Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation, [2017] OJ L 220/1, Articles 40-53.
[48] Directive (EU) 2019/944 on common rules for the internal market for electricity and amending Directive 2012/27/EU, [2019] OJ L 158/125, Article 19.
[49] RED II, supra note 12, Article 20. Domestic batteries are defined as stand-alone rechargeable batteries of rated capacity greater than 2 kwh, which are suitable for installation and use in a domestic environment.

vehicle data related to the battery state of health, battery state of charge, battery power setpoint, battery capacity, as well as the location of electric vehicles to electric vehicle owners and users, as well as to third parties acting on their behalf (such as electricity market participants and electromobility service providers), under non-discriminatory terms and at no cost. In addition, Member States shall ensure that non–publicly accessible normal power charging points (i.e., allowing for a transfer of electricity to an electric vehicle with a power output less than or equal to 22 kW) installed in their territory can support smart charging functionalities and, where appropriate, bidirectional charging functionalities.

The revision of the RED would complement the provisions on access to battery data related to facilitating the repurposing of batteries in the proposed Regulation concerning batteries and waste batteries, which assigns to the Commission the task of setting up an electronic exchange system that should contain sortable and searchable information and data on rechargeable industrial batteries and electric vehicle batteries, respecting open standards for third party use.[50]

On the very same date of the proposed revision of the REDI, the European Commission also released the **AFIR** proposal as part of the Fit for 55 Package.[51] Under the AFIR proposal (revision of the alternative fuels infrastructure directive, turning it into a regulation), to meet the growing demand for EVs, all new publicly-accessible charging stations have to be digitally connected and capable of smart charging.[52] Such charging can, indeed, facilitate the integration of EVs into the electricity system further (as it enables demand response through aggregation and through price based demand response) and, in turn, system integration can be facilitated through bi-directional recharging.[53] The use of smart metering systems in combination with smart charging points can optimise recharging with benefits for the electricity system and for the end user.[54] Moreover, according to the AFIR proposal, the establishment and operation of recharging points for EVs should be developed as a competitive market with open access to all parties interested in rolling-out or operating recharging infrastructures.[55]

To these aims, the AFIR proposal establishes that operators of charging points shall ensure that all publicly accessible normal power charging points operated by them are: a) capable of smart recharging, and b) are digitally-connected (i.e., are able to send and receive information in real time, communicate bi-directionally with the electricity grid and the EV, and can be remotely monitored and controlled, including to start and stop the recharging session and to measure electricity flows).[56]

Further, the ex post evaluation of the Directive 2014/94/EU carried out by the European Commission found that while interoperability issues with physical connections persist, new issues have emerged over communication standards, including data exchange among the different actors in the electro-

[50] Proposal for a Regulation concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020, COM(2020) 798 final, Article 64.
[51] AFIR, supra note 10.
[52] Ibid., Recital 21.
[53] Ibid.
[54] Ibid., Recital 20.
[55] Ibid., Recital 23.
[56] Ibid., Article 5(7-8).

mobility ecosystem.[57] Therefore, under the AFIR proposal, operators of publicly accessible charging points shall ensure the availability of static data (geographic location of the charging point, number of connectors, number of parking spaces for people with disabilities, contact information of the owner and operator of the recharging station, identification codes, type of connector, type of current) and dynamic data (operational status, availability, ad hoc price) concerning infrastructure operated by them and allow accessibility of that data to all stakeholders.[58]

Finally, the role of buildings in relation to smart charging and bidirectional charging is acknowledged by the proposed revision of the **EPBD**, as charging points where electric vehicles typically park for extended periods of time (such as where people park for reasons of residence or employment) are highly relevant to energy system integration.[59] To facilitate development of new services related to buildings, the proposed revision of the EPBD establishes that Member States shall ensure that the building owners, tenants and managers can have direct access to their building systems' data and, at their request, the access or data shall be made available to third parties.[60] Building systems data shall include at least all data related to the energy performance of building elements, the energy performance of building services, building automation and control systems, meters and charging points for e-mobility.

The proposed revisions of the RED and EPBD represent further examples of *in situ* data right already envisaged in the PSD2.

[57] European Commission, Commission Staff Working Document on 'Evaluation of Directive 2014/94/EU of the European Parliament and of the Council on the deployment of alternative fuels infrastructure', SWD(2021) 637.
[58] AFIR, supra note 10, Article 18(2).
[59] EPBD, supra note 11, Recitals 36, 37, and 39.
[60] Ibid., Article 14.

4. REGULATORY CHALLENGES FOR SMART CHARGING

Against this backdrop, the main regulatory challenges appear to be represented by the policy choices related to interoperability and standardisation, in particular the option for a mandated rather than a facilitated API adoption, and the concerns about privacy and cybersecurity.

4.1 APIs, standardisation, and interoperability

As already mentioned, APIs have been usually identified as a key enabler of interoperability. By allowing a firm to easily access the data gathered by another company, APIs are set to strengthen interoperability among different players and facilitate the exchange of data streams or datasets between data holders. However, data sharing via APIs requires a complex implementation process and sound standardisation initiatives are crucial for its success. Albeit a consensus progressively emerged on the fact that a systematic adoption of open and standardised APIs is essential, European policymakers have not taken a clear stance towards **standardisation** so far, regarding **who should define the APIs**.

Notably, Article 20 of the GDPR does not provide detailed guidance on how to ensure data portability among undertakings, but it merely states a general requirement for the format of transmitted data, which need to be structured, commonly used, and machine readable. Any attempt to mandate the adoption of interoperable standards is excluded as Recital 68 does not go beyond a simple encouragement.

In a similar vein, regarding the access to account rule under the PSD2, the EU has refrained from publicly mandating API standardisation and has left banks free to come up with their own data sharing interfaces or to take part in privately led standardisation initiatives. The underpinning rationale was hinged on the concern that a common API standard could jeopardise innovation and dynamic competition between standards. However, launching the Digital Finance and the Retail Payments Strategies in 2020, the European Commission has recognised that the lack of APIs interoperability hindered newcomers and committed to establish an Open Finance framework by the end of 2024 as well as to review the PSD2.[61] Further, the European Payment Council has recently established a work block, consisting of experts and representatives of interested European standardisation initiatives, with the goal of developing minimum requirements that ensure pan-European harmonisation and interoperability as well as the integrity of the scheme.[62]

The DMA and the Data Act confirm the recognition of the key role played by interoperability and standardisation. In particular, the European Commission has acknowledged that the absence of an obligation to create technical interfaces for automated and continuous data flows in the context of

[61] European Commission, 'Digital Finance Strategy for the EU', COM (2020) 591 final; Id., 'Retail Payments Strategy for the EU', COM (2020) 592 final.

[62] European Payment Council, 'Call for European standardisation initiatives in the field of PSD2 API's to participate in the API Work Block of the SEPA Payment Account Access Multi-Stakeholder Group', (2022) https://www.europeanpaymentscouncil.eu/news-insights/news/call-european-standardisation-initiatives-field-psd2-apis-participate-api-work. Similar efforts have been previously undertaken by the European Banking Authority (https://www.eba.europa.eu/regulation-and-policy/payment-services-and-electronic-money/eba-working-group-on-apis-under-psd2) and the Euro Retail Payments Board (https://www.ecb.europa.eu/paym/groups/erpb/shared/pdf/11th-ERPB-meeting/Report_from_the_ERPB_WG_on_a_SEPA_API_Access_Scheme.pdf).

IoT "can make it hard to offer certain services that require real time data flows, leading to lock-in situations for data subjects and hampering the development of innovative services based on access to such data."[63] In a similar vein, in the EHDS, the European Commission pointed to the absence of binding or compulsory standards across the EU and consequently limited interoperability[64]: "due to different standards and limited interoperability, industry faces barriers and additional costs both nationally and when entering the markets of other Member States".[65] Notably, given the fragmentation of standards and specifications for storing and sharing data, the digital health industry faces problems when placing new products and services on the market, and this often forces healthcare providers to adopt new standards that erect barriers to new entrants.[66]

However, all these interventions rule out the possibility of mandating the adoption of technical standards or interfaces but opt for providing the European Commission with the power to request EU standardisation organisations to draft harmonised standards defining common technical specifications in case they do not exist or are considered insufficient.[67]

In the case of smart charging, the need for a clear policy intervention to allow standardised and safe data sharing by promoting the development the adoption of harmonised standards is confirmed by the substantial lack of standards available.

A relevant exception, for the bidirectional communication between EVs and charging stations, is represented by **the ISO 15118 standard**, also known as "Road Vehicles – Vehicle to Grid Communication Interface." The International Organization for Standardization is a worldwide federation of national standards bodies, and its 15118 standard is the result of a working group involving experts from the automotive and the utility industries to develop an international communication standard for charging EVs and enable the integration of EVs into the smart grid. To this aim, the 15118 standard gives guidance on what information should flow between different parts of the chain and defines the communications protocol between the charging station and the EV regardless of a particular charging type, hence supporting both wired and wireless charging applications, and the pantographs that are used to charge larger vehicles (e.g., buses). The protocol enables the plug & charge feature which, once the EV is plugged into the charging point, allows the EV to automatically identify itself to the charging station and receive instant authorisation to initiate the charge of its battery. Currently, it is not clear whether the standard allows the vehicle to learn about alternative sources (and prices) of supply and to select one.

The potential role of the ISO 15118 standard is explicitly recognised by the Federal Highway Administration (FHWA) of the U.S. Department of Transportation in its recent notice of proposed rulemaking on minimum standards and requirements for projects funded under the National Electric

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[63] European Commission, 'Data Act (including the review of the Directive 96/9/EC on the legal protection of databases) – Inception Impact Assessment', (2021) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13045-Data-Act-&-amended-rules-on-the-legal-protection-of-databases_en

[64] EHDS, supra note 38, Explanatory memorandum, 9-10.

[65] European Commission, 'A European Health Data Space: harnessing the power of health data for people, patients and innovation', COM(2022) 196 final, 5.

[66] Ibid., 6.

[67] DMA, supra note 34, Article 48; Data Act, supra note 4, Article 28; EHDS, supra note 38, Article 23; Electricity Directive, supra note 48, Article 24; AFIR, supra note 10, Article 19(6-7) and Annex II(9); EPBD, supra note 11, Article 14.

Vehicle Infrastructure (NEVI) Formula Program.[68] Notably, although acknowledging that there is not a history of unanimous support for ISO 15118, FHWA states that such a standard provides an important industry baseline and views the prevailing trend of the US domestic EV market's reference for ISO 15118 as evidence that it provides an appropriate standard to reference in the proposed rule.[69]

Against this background, it is worth noting the different approach endorsed by the UK policymaker which stands out as one of the most advanced cases of mandated interoperability in the digital economy. Following a review of retail banking, the Competition and Markets Authority made full use of its market investigation powers to ease the functioning of the access to account rule enshrined in the PSD2 requiring the nine major banks in Britain and Northern Ireland to agree on **common and open API standards, data formats, and security protocols** that would allow new entrants to calibrate their applications according to a single set of specifications.[70]

The global attention gained by the **Open Banking experience** convinced the UK Financial Conduct Authority and the Government to expand third-party data access and API standardisation to a broader range of financial services and products, bringing Open Finance into discussion.[71] This initiative is part of the broader Smart Data strategy under which the UK Government is looking to expand data access tools in all regulated markets, including the energy sector.[72] In a recent market study on electric vehicle smart charging, the Competition and Markets Authority explicitly referred to the UK Open Banking as a blueprint to fully maximise the benefits of smart charging, hence recommending the Government to set open data and software standards.[73] Open standards would reduce charging costs and provide flexibility to the electricity system, while helping to generate more competition and innovation by ensuring that users are not locked in to the charge point operator's interface, but have a choice of alternatives to manage the charge point from third-parties.

Since interoperability is context-dependent, regulatory strategies require an in-depth understanding of market features and dynamics. Notably, it is worth investigating whether data sharing regimes and solutions experienced in other scenarios may be effectively adapted to the electricity sector and to the case of smart charging. It should, for instance, noted that the banking industry is much more mature the EVs industry, hence there is a risk that mandating specific solutions in a market at early stage may undermine innovation and lower incentives to invest. Moreover, it is necessary to assess

[68] U.S. Department of Transportation, 'National Electric Vehicle Infrastructure Formula Program', (2022) Docket No. FHWA-2022-0008, https://www.transportation.gov/briefing-room/biden-harris-administration-takes-key-step-forward-building-national-network-user.

[69] Ibid., 41.

[70] UK Competition and Markets Authority, 'The Retail Banking Market Investigation Order 2017', https://www.gov.uk/government/publications/retail-banking-market-investigation-order-2017. See Oscar Borgogno and Giuseppe Colangelo, 'Consumer inertia and competition-sensitive data governance: the case of Open Banking', 9 Journal of European Consumer and Market Law 143 (2020).

[71] UK Financial Conduct Authority, 'Open finance – Feedback Statement', (2021) https://www.fca.org.uk/publication/feedback/fs21-7.pdf. By taking stock of the UK experience, Australia introduced an ambitious economy-wide data-sharing framework, the Consumer Data Right, which gives consumers the right to share their data between any kinds of service providers of their choosing. In 2019, this regime was initially implemented within the banking sector, with the Australian Competition and Consumer Commission requiring the four major banks to share product reference data with accredited data recipients, mandating the adoption of a single set of API standards for data sharing.

[72] UK Government, Department for Business, Energy and Industrial Strategy, 'Smart Data Working Group', (2021) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/993365/smart-data-working-group-report-2021.pdf.

[73] UK Competition and Markets Authority, 'Electric Vehicle Charging market study', (2021) https://www.gov.uk/cma-cases/electric-vehicle-charging-market-study.

promises and perils of mandating, rather than merely facilitating, the adoption of APIs and whether it is appropriate to envisage asymmetric data access rights. Indeed, when it comes to the implications in terms of competition, data sharing initiatives involve relevant trade-offs. With specific regard to Open Banking and the effectiveness of the PSD2 data sharing rule in fostering competition, concerns like those already illustrated in the case of GDPR have been expressed. Notably, some studies warn against the entry of large online platforms into retail banking maintaining that large technology companies may disrupt retail banking markets by harnessing the massive quantities of data generated by their networks.[74] Others, instead, argue that, since empirical evidence suggest that FinTech start-ups are set to cooperate (rather than compete) with incumbent banking players, *ex ante* regulatory measures imposed on large online platforms could end up shielding banks from any competitive pressure, thereby frustrating the very aim of the PSD2.[75]

Yet, the UK's experience in the implementation of Open Banking provides a useful example of the challenges related to interoperability requirements. As the market investigation remedy is entering the final stage of implementation, the CMA has launched a consultation on the future governance of Open Banking.[76] Since the current proposal would allow the nine largest banks to withdraw from membership (and funding duties) after three years, several fintech players complain that this option would easily turn into unfair leverage to influence the new supervisor's behaviour, especially when it comes to standard setting and monitoring of interoperability requirements.

4.2 Data protection and cybersecurity

Digitalisation brings challenges on privacy and cybersecurity matters which significantly affect data sharing practices and the adoption of standards. These issues are particularly relevant for the energy sector. As digitalisation increasingly exposes the energy system to cyberattacks and incidents that may jeopardise the security of energy supply, policy measures are needed to ensure that new markets based on energy data are not only open and competitive, but also compliant with data protection and cybersecurity.[77]

The interface between the GDPR and the recent and ongoing European data sharing initiatives is the subject of a lively debate.

Notably, although the proposal for a Data Act aligns with the GDPR supporting the principles of **data minimisation** and data protection by design and by default[78], however, as noted by the European Data Protection Board and the European Data Protection Supervisor, the provisions introducing the new data access and sharing right do not prescribe neither that the products should be designed in a way that data subjects are allowed to use them anonymously (or in the least privacy intrusive way) nor

[74] Xavier Vives, 'Digital Disruption in Financial Markets', 11 Annual Review of Financial Economics 243 (2019); Miguel de la Mano and Jorge Padilla, 'Big Tech Banking', 14 Journal of Competition Law and Economics 494 (2018).
[75] Oscar Borgogno and Giuseppe Colangelo, 'The data sharing paradox: BigTechs in finance', 16 European Competition Journal 492 (2020).
[76] UK Competition and Markets Authority, 'The future oversight of the CMA's open banking Remedies', (2021) https://www.gov.uk/government/consultations/future-oversight-of-the-cmas-open-banking-remedies/the-future-oversight-of-the-cmas-open-banking-remedies.
[77] European Commission, supra note 2, 2.
[78] Data Act, supra note 4, Recital 8.

that data holders should anonymise data as much as possible.[79] In contrast, it is worth noting that, in the business-to-government data sharing Chapter, the Data Act states that the data holder should take reasonable efforts to anonymise the data or, where such anonymisation proves impossible, should apply technological means such as pseudonymisation and aggregation, prior to making the data available.[80]

On a different note, applying the GDPR's data minimisation principle, the EHDS states that, in addition to the tasks necessary to ensure effective secondary use of health data, the health data access bodies should apply tested techniques that ensure electronic health data is processed in a manner that preserves the privacy of the information contained in the data for which secondary use is allowed, including techniques for pseudonymisation, anonymisation, generalisation, suppression and randomisation of personal data.[81] Notably, the use of anonymised electronic health data which is devoid of any personal data should be made available when possible and if the data user asks it;[82] where the purpose of the data user's processing cannot be achieved with anonymised data, taking into account the information provided by the data user, the health data access bodies shall provide access to electronic health data in pseudonymised format. Moreover, given the sensitivity of electronic health data, all secondary use access to the requested electronic health data should be done through a **secure processing environment** and the processing of personal data in such a secure environment should comply with the GDPR.[83] By means of implementing acts, the Commission will assist Member States in developing common security standards providing for the technical, information security and interoperability requirements for the secure processing environments.[84]

With specific regard to the electricity sector, the Regulation on the internal market for electricity assigns specific responsibilities on data protection and cybersecurity to Transmission System Operators (TSOs) and Distribution System Operators (DSOs).[85] Their respective European associations (ENTSO-E) and the European entity for DSOs (EU DSO Entity) are required to promote cybersecurity and data protection in cooperation with relevant authorities and regulated entities. Further, the European Commission is empowered to adopt delegated acts on sector-specific rules for cybersecurity aspects of cross-border electricity flows, including rules on common minimum requirements, planning, monitoring, reporting and crisis management.[86] Moreover, the Electricity Directive specifically states that the security of the smart metering systems and data communication shall comply with relevant Union security rules, having due regard of the best available techniques for ensuring the highest level of cybersecurity protection.[87]

[79] European Data Protection Board and European Data Protection Supervisor (2022), 'Joint Opinion 2/2022 on the Proposal of the European Parliament and of the Council on harmonised rules on fair access to and use of data (Data Act)', https://edpb.europa.eu/our-work-tools/our-documents/edpbedps-joint-opinion/edpb-edps-joint-opinion-22022-proposal-european_en.
[80] Data Act, supra note 4, Recital 64 and Article 20(2).
[81] EHDS, supra note 38, Recitals 43 and 49.
[82] Ibid., Article 44(2) and (3).
[83] Ibid., Article 50 and Recital 54.
[84] Ibid..
[85] Regulation (EU) 2019/943 on the internal market for electricity [2019] OJ L 158/54, Articles 30 and 55.
[86] Ibid., Article 59(2)(e).
[87] Electricity Directive, supra note 48, Art. 20.

Finally, in order to support the creation of a European energy data space, the forthcoming European Commission's Communication "*Action plan on the digitalisation of the energy sector*" will also propose actions to create a cyber-secure data exchange infrastructure in the energy system, which has been identified as one of the key area of the intervention in the Action Plan.[88] Notably, the Action plan will be aligned with the general framework for cybersecurity, in particular the proposed NIS-2 Directive[89], the proposal for a Cyber Resilience Act[90], and the planned **Network Code on Cybersecurity** (NCCS) of cross-border electricity flows to be adopted in accordance with the Regulation on the internal market for electricity.[91] In the latter regard, in January 2022 the ENTSO-E and the EU DSO Entity have submitted to the Agency for the Cooperation of Energy Regulators (ACER) their joint proposal for the NCCS, which aims to set a European framework for the cybersecurity of cross-border electricity flows.[92]

4.3 The UK experience

As shown in the previous paragraphs, the access to the full range of benefits from smart charging requires technical solutions aimed at ensuring both data sharing and protection from risks of data breach and cybersecurity attacks. Regarding the former issue, interoperability is essential to allow charge points to receive and send information, and to promote a competitive market by enabling consumers to easily switch among different suppliers. Further, cyber and data security risks can threaten the stability of the electricity system and undermine consumers trust and engagement, thus jeopardising the effective uptake of smart charging.

Against this background, the UK experience is worth analysing since the UK Government has recently approved a plan to mandate, as of 30 June 2022, smart charging capability for all new home and workplace charge points. The Government has set out a phased approach to intervention, first acting to increase smart charging and ensure minimum protections for consumers, and then developing a system-wide approach to regulation across a broad range of smart devices and systems.

Notably, in 2019, the UK Government launched the 'Electric vehicle smart charging consultation' to gather evidence and suggestions on how to maximise and best implement the use of smart charging technologies in particular with regard to cybersecurity and interoperability issues.[93] Among the policy options available, to support the smart charging market in the early stage the UK Government opted for the introduction of a minimum set of mandatory requirements for new private charge points aimed at ensuring that charge points have smart functionality (allowing the charging of an electric vehicle when there is less demand on the grid or when more renewable electricity is available) and meet

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[88] European Commission, supra note 2, 3.
[89] Supra note 8.
[90] European Commission, 'Call for evidence for an impact assessment on a Cyber Reselience Act', (2022) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13410-Cyber-resilience-act-new-cybersecurity-rules-for-digital-products-and-ancillary-services_en.
[91] Regulation 2019/943, supra note 85, Article 59(9).
[92] https://www.entsoe.eu/network_codes/nccs/.
[93] https://www.gov.uk/government/consultations/electric-vehicle-smart-charging.

certain device-level requirements, enabling a minimum level of access, security and information for consumers.

In particular, pursuant to 'The Electric Vehicles (Smart Charge Points) Regulations 2021', EV charge points must: i) have smart functionalities (i.e., it should be able to send, receive information and respond to messages by increasing or decreasing the rate of electricity flowing and shift the time at which electricity flows); ii) guarantee supplier interoperability (therefore, must not be designed in a way that means they lose functionality when a consumer switches supplier); iii) have appropriate basic security measures to ensure that its functions are resilient to cyber-attack (where relevant, requirements in line with the ETSI EN 303 645 standard will be mandated to achieve this); iv) continue charging even if the charge point ceases to be connected to a communications network (i.e., charge points have to rely on a network connection to meet the smart requirements, for example using Wi-Fi, so that when the network connection is lost, the charge point must still be capable of charging an EV, to ensure users can always charge their vehicle when they need to); v) be pre-set to not charge at times of high demand (off-peak charging) to help mitigate the risk that some users do not engage with smart charging offers; vi) have a randomised delay function to mitigate the risk that charge points all turn on or off simultaneously causing grid instability, due to the sharp increase or decrease in electricity demand from EVs; vii) measure or calculate the electricity consumed and/or exported, the time the charging event lasts, and provide a method for the consumer to view this information (monitoring and metering of energy consumption).[94]

As highlighted in its Impact Assessment, the Government faced a difficult trade-off, given that the diversity in business models and practices, whilst important for innovation, risks a proliferation of smart charge point systems developing with varying standards and functionality: "Without clear requirements and standards set for the industry, it's unlikely that the market will deliver smart [charge points] that provide sufficient grid and consumer protection, at least in the short term."[95]

In this regard, the final option selected in the UK Regulation 2021 is different from the one presented at consultation which included further regulatory requirements by mandating standards for cyber and data security, grid stability, and charge point operator interoperability. Notably, about data privacy and cybersecurity, the consultation proposed to mandate compliance with the British Standards Institution (BSI) standard PAS 1878 for Energy Smart Appliances; and, on the interoperability issue, the consultation proposed that smart charge points should be capable of retaining smart functionality if the charge point operator were to be changed, without requiring a visit to the premises. However, according to the Impact Assessment, there is limited evidence for mandating specific solutions that meet all of Government's smart charging policy objectives, while there is a risk of wasted investment in developing products that may not meet requirements that could be changed to align with the future framework.[96] Further, there is a concern that such an approach may hamper rather than encourage

[94] https://www.legislation.gov.uk/uksi/2021/1467/contents/made.

[95] UK Government, 'Impact Assessment on The Electric Vehicles (Smart Charge Points) Regulations 2021', (2021) 1, https://www.legislation.gov.uk/uksi/2021/1467/impacts.

[96] Ibid., 14.

future innovation: indeed, "[r]egulating a market at this early stage could reduce the number of innovative smart charging offers and solutions developed."[97] Given the uncertainties about how the sector and technology will evolve, strategies and measures for the development of EV charging must be flexible.

In this scenario and about data sharing, as already mentioned, in a market study conducted on EV smart charging the CMA identified the lack of open standards as a key issue, thus recommending the Government to set open data and software standards for home charge points which would enable compatibility of home charge point interface systems with third parties.[98] Indeed, otherwise consumers risk being tied to a specific operator, while open standards would allow them to shop around.[99]

Charge point operators, instead, raised concerns around requirements for full interoperability between charge point hardware and the proprietary operating systems of other providers. Such full interoperability would enable that different operating systems could be used with different home charge points, as well as the charge point kit being compatible with EVs and energy tariffs.[100] Similarly to the evidence gathered in the UK Government Impact Assessment, charge point operators generally considered this kind of interoperability to be inappropriate at this early stage of the sector because it could disincentivise investment and innovation. In this regard and mentioning the Open Banking remedy, the CMA underlined that open data could bring significant benefits for consumers, hence interoperability requirements should focus on the need for open data standards, rather than necessarily requiring software systems of different providers to be interchangeable and compatible with all charge point hardware.[101]

In sum, according to the CMA, open data standards should be embedded in home charging infrastructure. Indeed, in light of the previous experience in retail banking, open standards for controlling the charge point and accessing charge point usage data can help to fully maximise the benefits of smart charging by simplifying and automating it.[102] Notably, open standards can ensure that people are not locked in to the charge point operator's interface, but have a choice of alternatives to manage the charge point from third-parties. Further, since a charge point may need to be able to communicate with another third-party (an aggregator or flexibility provider), open standards for controls and data used by home charge points can help to do this by simplifying and automating smart charging. Moreover, open standards would make it easier for third parties to develop innovative solutions and applications.

[97] Ibid., 44.
[98] UK Competition and Markets Authority, supra note 73, Appendix C, 7.
[99] Ibid., Appendix C, 9-10.
[100] Ibid., Appendix C, 10.
[101] Ibid., Appendix C, 10.
[102] Ibid., 87-88.

4.4 The US experience

The relevance of defining common and open API standards, data formats, and security protocols is shared by the U.S. Administration.

In response to the Executive Order signed by U.S. President Biden to promote competition[103] and the Bipartisan Infrastructure Law to build out a national EV charging network of 500,000 EV chargers by 2030[104], the FHWA of the U.S. Department of Transportation has recently announced a notice of proposed rulemaking on minimum standards and requirements for projects funded under the NEVI Formula Program.[105] By providing the States with the groundwork to build charging station projects, the notice aims at ensuring that national EV charging network is user-friendly, reliable, and interoperable between different charging companies, with similar payment systems, pricing information and charging speeds.

Notably, to implement federally-funded charging station projects in a standardised fashion, the FHWA proposes to establish regulations that would set **minimum standards** with regard to the following areas: the installation, operation, or maintenance of EV charging infrastructure; the interoperability of EV charging infrastructure; traffic control device or on-premises signage acquired, installed, or operated in concert with EV charging infrastructure; data, including the format and schedule for the submission of such data; network connectivity of EV charging infrastructure; and information on publicly available EV charging infrastructure locations, pricing, real-time availability, and accessibility through mapping applications.

With specific regard to the interoperability of EV charging infrastructure, the proposed Section 680.108 would promote industry standards for charging infrastructure consistent with standards outlined in ISO 15118.

Further, the FHWA proposes to set minimum standards for the charging network connectivity of EV charging infrastructure to include charging network communication, charging network–to–charging network communication, and charging network–to–grid communication. For charger–to–charging network communication the proposed Section 680.114(a) refers to the Open Charge Point Protocol (OCPP), an open protocol providing a method of communication between any type of charger and a charging network to allow remote monitoring and management of one or many chargers. OCPP is considered an industry standard that is designed to work in tandem with ISO 15118 to enable smart charge management and plug and charge communications protocols.

Moreover, to address cybersecurity threats to the electric grid, Section 680.114(c) proposes to require that charging networks be capable of secure communication with electric utilities, other energy providers, or local energy management systems.

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103 U.S. White House, 'Executive Order on Promoting Competition in the American Economy', (2021) https://www.whitehouse.gov/briefing-room/presidential-actions/2021/07/09/executive-order-on-promoting-competition-in-the-american-economy/.

104 U.S. DEPARTMENT OF TRANSPORTATION, 'President Biden, USDOT and USDOE Announce $5 Billion over Five Years for National EV Charging Network, Made Possible by Bipartisan Infrastructure Law', (2022) https://highways.dot.gov/newsroom/president-biden-usdot-and-usdoe-announce-5-billion-over-five-years-national-ev-charging

105 Supra note 68.

Finally, minimum standards for chargers are proposed to communicate their status with consumers and third-party mapping applications. Notably, recognising the important role played for consumers by third-party mapping applications communicating real-time and geolocated information, FHWA proposes in Section 680.116(c) that States ensure several data elements are made available, free of charge, to third party software developers, via APIs. The FHWA also proposes to require the availability to third party software developers of two real-time datasets updated at a frequency that meets reasonable expectations which should include real-time status of each charging port and real-time price to charge. The proposed real-time dataset requirements refer to the Open Charge Point Interface (OCPI) 2.2, which defines the standardised content and format of data needed to communicate status and price. OCPI is an open protocol which defines communication between charging network providers, charging station operators, and other entities to improve the EV charging customer experience by allowing roaming, so EV charging customers can use a single credential at charging stations operated by different charging station operators and/or charging network providers.

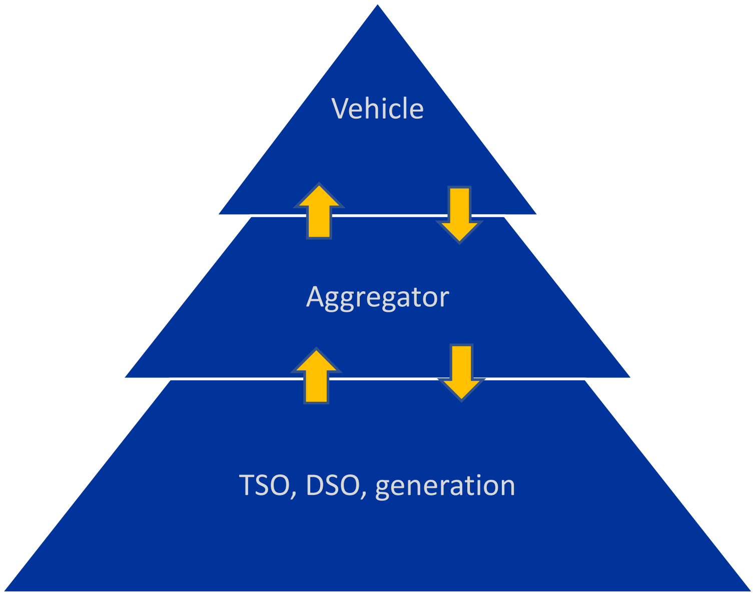
5. BI-DIRECTIONAL SMART CHARGING SCENARIOS

To better understand the types of data sharing and standards that may be relevant for the future of bidirectional smart charging, we identify here **four contracting scenarios**. The purpose of describing the scenarios is not to fully develop the use case and success criteria for each, but rather to illustrate the varied circumstances that could occur for data flows and contracting. Ensuring that data flows can effectively support multiple scenarios could be important for allowing flexibility considering local circumstances and demand, as well as for generating future innovations. Each scenario features different parties to the core energy transaction and may have different implications for cybersecurity. We here focus on bidirectional charging. We do so on the grounds that current higher costs for bidirectional stations compared to unidirectional ones are likely to fall with volume. Estimates of costs of bidirectional charging stations are based on costs from early production runs, with practical experience suggesting that even modest levels of volume will create dramatic reductions in production costs. All scenarios would require cybersecurity that allowed for car movement and potential variable location of battery charging and battery to-grid energy supply.

In practice, one could expect a variety of schemes to co-exist, particularly in the early era of bidirectional smart charging that is likely coming soon. Whatever regime selected by users would need to be sufficient to incentivise charging stations to have smart and bidirectional capability and to incentivise the appropriate investment in cybersecurity over transactions.

The typical path of travel for electricity transactions would be based on a potential three-part structure, as illustrated in the pyramid of Figure 1.

Figure 1. Core transaction patterns, bidirectional smart charging



Source: Authors

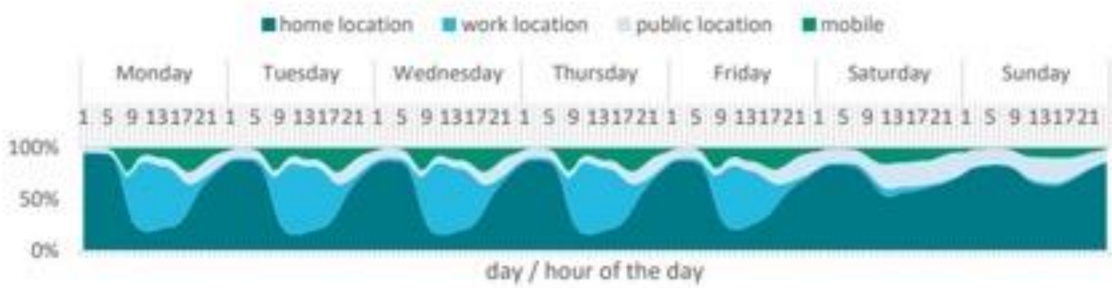
The opportunity for bidirectional charging exists in large part because arbitrage is possible due to the variation in costs for electricity over the course of the day as well as from the value of frequency regulation that may occur over much shorter time periods. The ENTEC study suggests that the price differential can be of the order of 100% across the day (e.g., from 33 to 67 EUR), with a possible arbitrage gain of 340 EUR per year for a single vehicle, and these estimates are a substantial understatement with respect to 2022 energy prices. While these gains are modest on a daily basis, they can play a substantial role in system balance, particularly with large quantities of renewable generation.[106] They are sufficiently modest, though, that no individual car owner would likely wish to monitor prices actively over the course of the day and select buy and sell times. For this reason, passive and pre-programmed patterns may be more likely to yield energy flow benefits, though possibly with ability to change an obligation, due for example to an unexpected or emergency need to use their car.[107]

It is worth noting that optimal charging and supply to grid moments may vary over the course of the day, just as car locations may vary across the day (see Figure 2). The basing of a transaction at a specific charging point will therefore limit the bidirectional capability of transactions to some extent. An ideal system would allow uploading of supply to the building and then the grid when the electricity pricing justifies it, wherever the car was initially charged and wherever the car may be parked.

[106] ENTEC, 'Digitalisation of Energy Flexibility (Revised Report)', Energy Transition Expertise Centre, prepared by Fraunhofer Institute for Systems and Innovation Research ISIGuidehouse, McKinsey & Company, Inc, TNO, Trinomics, Utrecht University, (2022) https://energy.ec.europa.eu/digitalisation-energy-flexibility_en

[107] The arrival of large scale bi-directional charging could potentially reduce the arbitrage differential by increasing demand (and prices) at the periods of low cost productions.

Figure 2. Availability of EVs by location and day of week



Source: Gnann, Kingler and Kühnbach (2018)[108]

This locational variability adds a layer of complexity to the contracting problem because it requires that appropriate financial incentives be provided to charging station suppliers (which may sometimes be the car owner though often not) such that they do not lose money from engaging in the bidirectional charging system and can earn revenues from the transactions, even if small.

The possibility that charging stations could serve as a unique path, once a car is parked, for getting energy into the network could give them market power unless otherwise overseen, which could allow them to appropriate all the gains from the battery investment, unless otherwise overseen or unless competitive forces between chargers prevent such a use of market power.

We have developed four core scenarios that illustrate different contractual paths that could develop between the battery owner and users of energy generated by the battery. These are thus scenarios that particularly focus on the return path of energy to users from the storage holders.

Scenario 1: Vehicle to grid

In the first scenario, the individual car owner would contract directly with an open market for small scale purchase and sale of electricity. This scenario is essentially hypothetical now but may be considered as one possibility for the future involving the least centralised transactions possible and, in particular, as a backup negotiating position for car owners who might otherwise be limited in their transacting partners. Such transactions would then be monitored through an exchange that would ensure contracted quantities were exchanged at the prices agreed. Even if individuals will not engage in regular hourly contracts, they may sell and buy futures, or simply put their capacity and likely locations into a network. This open futures and spot exchange of demand or supply would then be able to feed energy directly into the grid at predicted points and with time-predictable flows. The pricing in the exchange would need to be connected to broader system operator arrangements with generators.

[108] Till Gnann, Anna-Lena Klinger, and Matthias Kühnbach, 'The load shift potential of plug-in electric vehicles', 390 Journal of Power Sources 20 (2018).

Even if this scenario is deemed less likely in some respects than others, taking it seriously as a hypothetical transactional scenario has two advantages: first, engaging the individual user in the transaction is likely to provide increased comfort on the part of the car owner and increased willingness to transact, due to the sense of control. Survey evidence suggests that users will be reluctant to give control over their car to others, as they assign a positive option value to the ability to use the car at will. Second, allowing the option of consumer direct sales provides an escape valve in case intermediaries seek to unduly control transactions and appropriate the gains from the sunk costs of the battery investment.

Scenario 2: Vehicle to aggregator to grid

In the second scenario, individual car owners will transact with “aggregators” or “virtual power plants” who will serve a dual role of organising the smart charging of a battery so that demands on the system for electricity consumption could be held off during peak moments of aggregate demand, and also serve as the coordinator of activation of some or all of their associated vehicles for provision of electricity to the network in a way that could be monitored and reimbursed by the network, as for generators. The aggregators would separately handle the contracting and incentivising of car owners and the relationship to arbitrage.

Competition between aggregators would help to create multiple options for car owners so that they could ensure they would reap many of the benefits of their battery investment. The arrangement with charging stations would also, in part, be arranged by aggregators. The purchase of electricity for pure transport use, though, would remain as much as possible with the car owners to ensure that their driving choices reflect costs of their vehicle operation.

Some aggregators may end up being much like existing demand reduction aggregators. But others may be based on physical location. It is expected that multi-user buildings will become major centres of charging in the future, due to obligations to install charging facilities for one in five space and conduits for more, in addition to the potential incentive of serving as an aggregator and potential user of the supply. This requirement arises from the EPBD. The role of buildings as potential users of supplied energy could be derived from consideration of whether a building would rather pay the market price of supply or the market price of generation (that is lower due to excluding network costs). If possible, buildings would seek to take energy therefore from local supplies, such as batteries on site, rather than purchase from the local distributor.

Building may thus have charging stations that offer battery charging. The price of such charging will depend on whether the charging stations themselves are “open” and will allow multiple energy suppliers to provide energy to a battery, or whether the charging stations are “closed” with a unique supplier. The charging stations may also have supplemental charges to ensure that the charging station investor recovers the cost of their investment and earns a return, just as petrol stations charge a mark-up on the cost of their petrol.

Scenario 3: Vehicle to car manufacturer to grid

In the third scenario, individual car owners will transact with virtual power plants organised by the car manufacturers. The car manufacturers may have an incentive to build into their cars unique and proprietary standards for bidirectional smart charging, to ensure that consumers have no choice over the aggregator they use but would have to use an aggregator with the legal access to the proprietary technology and data.

This approach may seem the most guaranteed to achieve high penetration of implemented bi-directional smart charging, due to the quick achievement of scale and possible high acceptance of owners to participate in the market when that is part of the initial car purchase transaction.

Unless the data and standards are accessible to third parties, the car manufacturers will be able to keep exclusive control over the arbitrage gains from bidirectional smart charging. While to some extent this may be competed away at the time of auto purchase as consumers negotiate between alternative car suppliers, it may be that consumers are more interested on other features of the car than the openness of their car's standard for smart charging, which could lead to low levels of competition at that level.

In addition, in many cases, users will have difficulty managing such a system, particularly with proprietary charging standards as discussed for the UK. In one example, company fleets of cars will have many brands in the same parking lot of a company. Imagine that one set of charging stations are managed by one car manufacturer solution and another group of charging stations are managed by another car manufacturers solution. A good optimisation in this case is impossible. In such a scheme, the company that owns the EVs will often prefer to use a single aggregator that manages all its vehicles of all branches, which is impossible V2G functions and energy data of the vehicle are not available.

Scenario 4: Vehicle to user: Grid bypass

In the final scenario, the car owner will transact directly with a user and provide power that does not use the facilities of the grid. This hypothesis is in line with other microgeneration scenarios in which individual homes, small businesses or small communities are off the grid. This occurs already to a very minor extent in Europe, largely due to some homes and facilities being too expensive to connect to the grid when found in remote and isolated locations. From a technical point of view in terms of energy and EV charging, the problems can remain like those with a grid. In fact, maintaining a stable frequency and energy supply may be even more difficult in such scenarios, placing a higher value on the inputs from reliable backups energy coming from EV.

In the limit, batteries could be used for self-powering a home that has small generation facilities of its own, such as PV or wind.

In such transactions, the sale of electricity from the vehicle could occur via direct contract with the user. Such contracts could avoid the need for a grid connection altogether. If they became common, they could have substantial effects of raising the grid costs, by reducing the number of users sharing the costs of the grid. Such scenarios could merit consideration of whether those departing the grid should pay an exit charge, in the sense that existing facilities were built with an expectation of having these leavers as members of the grid, and thus costs have been incurred on their behalf. On the other hand, if departures from the grid via direct contracting reduce the need for expensive upgrades of the grid, the leavers could be rewarded due to the costs such departures would allow the grid to avoid.

Each of these scenarios poses its own data flow challenges and may generate different forms of contracting, both in terms of pricing to car owners, timeline of commitment, ability to drive at will, etc. Scenarios 1 and 4 require the least degree of external oversight of the standards used in the contracting mechanism, because changing of transacting parties is not considered or expected. In contrast, changing of contracting parties is particularly likely in Scenarios 2 and 3, and these could probably be expected to constitute most owners and of capacity, given that scenarios 1 and 4 would currently constitute less than 1% of total energy production.

6. RECOMMENDATIONS

Considering the rapid development in both the rollout of EVs and of related charging infrastructure, and the apparent importance of ensuring bidirectional charging can work as one source of storage of excess production of renewable energy in the future, careful consideration is needed for how data will be handled in the operation of this service.

Risks of poor outcomes could come from failings in data security, payments demanded for intellectual property that are excessive or undue constraints imposed on contracting parties by intermediaries.

Unless the government chooses to bear the costs of investment in the charging infrastructure to ensure sufficient capacity is built for peak periods, it must rely on **private investment** for building out the infrastructure. Private investors will be motivated by sufficient prospect of profit to determine an interest to build out. The build out is expected to be staggered, in the sense that maximum ownership of EVs would not be expected until 2040 or so, with the likely retirement of petrol-powered vehicles. While buildings and individual users may have incentives to build their own smart charging, refuelling stations may not unless there is a satisfactory return. There is a potential risk of incompatibility of alternate charging infrastructures which limits rollout of both infrastructure and consumer choice of the type of car they will purchase.

Refuelling stations may have a lower need for bidirectional charging than other locations, due to the likely connect, charge and move on approach of drivers when refuelling. Requirements to open access to multiple providers of electricity for user options could reduce the returns to these intermediaries. This could be viewed as comparable to requiring petrol stations to offer petrol from multiple suppliers.

Broader infrastructure may need further investment to make charging possible in countries with limited distribution flexibility. But this possibility remains to determine, as evidence so far suggests that existing networks can handle the new element of smart charging.

Data flows will be crucial to determining which outcomes are provided by the market.

The environment for bidirectional smart charging across the EU remains to develop. But we have suggested some **principles** that can govern the period in which rollout occurs and after:

- Information provided in one format can be read by all other users eligible to access the data;
- Energy sources that are viable are given an incentive to produce as long as storage is expected to be profitable;
- Profitable storage is incentivised to occur and for batteries to be purchased; and
- Battery charging stations earn a sufficient return to also be incentivised to build out in line with expected future demand.

Some reports suggest that the EU will not need to take regulatory measures, instead leaving the rollout and technology to develop naturally. This is in contrast to the approach that was used for rollout of mobile telephony across Europe. While the EU may not wish to determine who contracts with who and under what conditions, it is **highly possible** that, unless rules and standards are developed within at least certain respects, the **full potential of market interactions will simply not be realised**. This is notably because smart charging depends first and foremost on the technology that is built into the car or battery. To the extent these are provided jointly, the producer of these may select to introduce technological constraints that are to their advantage and that limit the ability of customers to choose with whom they will contract and under what conditions.

We would thus suggest that serious consideration be given to:

1. **Requiring car manufacturers to adopt open and portable standards for battery charging and discharging with smart charging and V2G functions available to any third parties chosen by the customer.**
   - Such data standards would not need to be identical for all providers and countries.
   - Manufacturers should not circumvent these standards by, for example, refusing to sell ownership of all aspects of battery operation.
   - Cable and physical interfaces should not be limiting of data flows and data destinations, nor constraining of ultimate transacting partners.
   - While the EU may debate whether to impose requirements on car manufacturers, failure to require openness at an early stage is not likely to be counteracted by high demand for openness by customers and could create lock-in for car customers.
   - Information required for energy optimisation are sent by the vehicle to all parties authorised by the car owner.
   - Smart charging and V2G functions are accessible to any third party if final customers so decide.

2. **Ensuring that customers with no reasonable alternative are not locked by data systems into purchasing energy from one charger that does not offer competitive rates (though guaranteeing a fair return for charger installers) both for charging and selling of energy.**
   - Open data systems do not require a common communications standard, but rather openness of access to each standard.
   - Adopt the principle that data should be able to transit to and from contracting parties of the vehicle operator’s choice and of its agents (such as aggregators).
   - Ensure that standards for connection and payment allow a choice of supplier, where that option would exist through the charging station and network.

3. **Ensuring that privacy safeguards are in place to protect consumer information about their movements (and that these are not displaced by open data requirements).**
   - Privacy safeguards are to some extend already catered for by GDPR and Data Protection Regulation but could be over-ridden by other legislation.

4. **Ensuring the sufficient transactional standards are in place for payment and volume monitoring to ensure that energy payments are secure and going to or from the relevant battery in a secure manner.**

- A challenge from bidirectional charging is that it may involve payments to one (or more) origin source(s) while contributing energy to the network may result in payments from a different destination source(s).

5. **Avoid imposing obligations to suppliers to buy from EVs so that EVs must compete with other sources of energy and would not be guaranteed to provide energy when the economic conditions were not desirable nor be guaranteed prices above the market rate.**
   - Past prioritisation of renewable energy sources may have led to waste of government or end customer funds and excessive rates of return for investors.

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