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Disclaimer

This document has been produced in the context of the EV4EU project[1]. Views and opinions expressed in this document are however those of the authors only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the grating authority can be held responsible for them.

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[1] https://ev4eu.eu/

Executive Summary

The Deliverable *D11.2: Data Management Plan (DMP) - Update* provides a comprehensive overview of how data are collected, processed, and managed throughout the EV4EU (Electric Vehicles Management for Carbon Neutrality) project. It defines the principles, methodologies, and responsibilities governing all project datasets, ensuring alignment with the FAIR principles (Findable, Accessible, Interoperable, and Reusable), the General Data Protection Regulation (GDPR), and the Horizon Europe Open Science policy.

The document first introduces the general context of the EV4EU project highlighting the methodological framework adopted for data collection and management across Work Packages (WP). It then presents a detailed description of the data generated and used within the project, including their purpose, origin, type, format, and utility. These datasets originate from four main demonstrators, located in Portugal, Denmark, Slovenia, and Greece, and from simulation environments developed to evaluate large-scale electric vehicle (EV) integration, vehicle-to-everything (V2X) management strategies, and their impact on smart grids, cities, and markets.

A dedicated section addresses the Co-simulation platform developed in WP3, which integrates heterogeneous data sources to assess the dynamic interaction between EVs, energy systems, and user behaviour. Furthermore, the DMP encompasses the management of societal adoption data collected through surveys and interviews to understand user perceptions and behavioural responses to smart-charging and flexibility schemes.

For each data category, the DMP specifies procedures for ensuring data quality, security, documentation, storage, access control, and long-term preservation. Ethical considerations, personal data protection, and licensing conditions are also detailed to guarantee full regulatory compliance.

Finally, the DMP establishes the mechanisms for making anonymised and aggregated data publicly available through trusted repositories, promoting transparency, reproducibility, and reusability of results.

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Acronym

ACEA	European Automobile Manufacturers' Association
API	Application Programming Interface
ARC	Amager Resource Centre
ARSO	Environmental Agency of the Republic of Slovenia & ELES - Elektro Slovenija
BEOF	Bornholm Energy and Utility Company
BESS	Battery Energy Storage System
BUC	Business Use Case
CDR	Charging Data Record
CERIF	Common European Research Information Format
Cerius	Danish Electricity Distribution Company
COSEM	Companion Specification for Energy Metering
CP	Charging Point
CPO	Charge Point Operator
CRM	Customer Relationship Management
CSMS	Charging Station Management System
CSV	Comma-Separated Values
DBMS	Database Management System
DCC	Digital Curation Centre
DEI	Diversity, equity, and inclusion
DER	Distributed Energy Resource
DMP	Data Management Plan
DLMS	Device Language Message Specification
DR	Demand Response
DSO	Distribution System Operator
DTU	Technical University of Denmark
DUoS	Distribution Use-of-System
EAFO	European Alternative Fuels Observatory
EDA	Eletricidade dos Açores
EC	European Commission
Energinet	Danish Transmission System Operator
ENS	Energy not supplied

ENTSO-E	European Network of Transmission System Operators for Electricity
ERSE	Entidade Reguladora dos Serviços Energéticos
EU	European Union
EV	Electric Vehicle
EV4EU	Electric Vehicles Management for Carbon Neutrality
EVSE	Electric Vehicle Supply Equipment
FAIR	Findable, Accessible, Interoperable, and Reusable
FCR-D	Frequency Containment Reserve for Disturbances
FCC	Flexible Capacity Contract
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GEN-I	Slovenian Energy Trading and Aggregation Company
HEDNO	Hellenic Electricity Distribution Network Operator
HDV	Heavy-Duty Vehicle
HEMS	Home Energy Management System
IEC	International Electrotechnical Commission
IoT	Internet of Things
IST	Instituto Superior Técnico
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
LightGBM	Light Gradient Boosting Machine
LV	Low Voltage
MB	Megabyte
MILP	Mixed-Integer Linear Programming
MISP	Malware Information Sharing Platform
MV	Medium Voltage
NIDS	Network Intrusion Detection System
NSRD	National Solar Radiation Database
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
OICP	Open InterCharge Protocol
O-V2X-MP	Open Vehicle-to-Everything Management Platform

PCC	Point of Common Coupling
PCAP	Packet Capture (Network Data File Format)
PPC	Public Power Corporation
PV	Photovoltaic
Python	High-Level Programming Language for Data Analysis and Simulation
PyECOM	Python Energy Communities
RDA	Research Data Alliance
REN	Redes Energéticas Nacionais
RES	Renewable Energy Sources
RTP	Real-Time Pricing
SoC	State of Charge
SQL	Structured Query Language
TLS	Transport Layer Security
ToU	Time-of-Use
TSO	Transmission System Operator
V1G	Unidirectional Smart Charging
V2G	Vehicle-to-Grid
V2X	Vehicle-to-Everything
VPP	Virtual Power Plant
WP	Work Package

1 Introduction

1.1 General Context

EV4EU project complies with the Commission's Open Research Data Management, aiming at improving and maximising access to and re-use of research data generated in any funded projects. However, EV4EU follows a balanced strategy between data openness and protection of scientific information, commercialisation, Intellectual Property Rights (IPR), privacy concerns, security, as well as data management and preservation questions, thus EV4EU shall follow the concept of "*as open as possible as closed as necessary*".

The Data Management Plan (DMP) defines the data management life cycle for all data collected, processed, and generated throughout the EV4EU project. At this stage, all demonstrators have initiated the data generation phase and are currently analysing the results obtained. The DMP has evolved accordingly, consolidating the data management procedures effectively implemented across partners and sites. Most partners have published their datasets in trusted repositories and data infrastructures, providing open access where possible, under appropriate licensing schemes. Exceptions to open access have been duly justified within the scope of this DMP. Aligned with the FAIR principles (Findable, Accessible, Interoperable, and Reusable), this updated version includes comprehensive information on*: (i)* the handling and curation of research data during the project; *(ii)* the datasets collected, processed, and generated by each demonstrator; *(iii)* the methodologies and standards applied; *(iv)* the data shared and made openly accessible; and *(v)* the long-term preservation strategy for ensuring data availability beyond the project's duration.

1.2 Document Structure

This deliverable is organised into five main sections. Section 1 introduces the document, presenting the general context of the EV4EU project, its objectives, and its relationship with other deliverables within the consortium. It also provides an overview of the document's structure and its role within the overall data management strategy. Section 2 defines the DMP methodology and core concepts. It explains how data are collected, categorised, and evaluated across project activities, in line with the FAIR principles and Horizon Europe Open Science requirements. This section also includes detailed information on data types, formats, origin, size, and utility, as well as the approach to ensure accessibility, interoperability, security, and ethical compliance. Section 3 focuses on the data collected and generated within the four EV4EU demonstrators detailing their respective data collection approaches, datasets, and evaluation methods. Section 4 addresses the datasets related to scenario modelling and V2X impact assessment. It covers large-scale EV scenario data, business models, V2X management strategies, smart city and grid integration through the co-simulation platform, and the open V2X management platform data. Section 5 presents the data management approach for societal adoption studies, including the design, collection, and treatment of qualitative data from users and stakeholders involved in EV flexibility and smart-charging schemes.

Throughout the deliverable, cross-references to other EV4EU deliverables are included where relevant to ensure consistency and traceability. This DMP deliverable is supported and complemented by an additional artifact: the "Data Definition Catalogue", defined as an Excel file (xlsx format) available in the EV4EU SharePoint folder.

1.3 Relationship with Other Deliverables

The Data Management Plan (DMP) was developed under WP11 – Management and Data Management, and it is intrinsically connected to all project activities involving data generation, analysis, and validation across the EV4EU WPs. Beyond its coordination function, the DMP consolidates information from all technical and demonstration WPs to ensure consistency, traceability, and compliance with FAIR and GDPR principles. Data have been generated, reused, and analysed throughout the project, from scenario definition and modelling in WP1, management strategies in WP2, and simulation studies in WP4 and WP5, to user adoption assessments in WP3 and large-scale demonstration activities in WP6, WP7, WP8, and WP9 (Figure 1). This integrated approach ensures a coherent and harmonised framework for managing all data produced or analysed within EV4EU, supporting the project's scientific objectives and alignment with European Open Science standards.

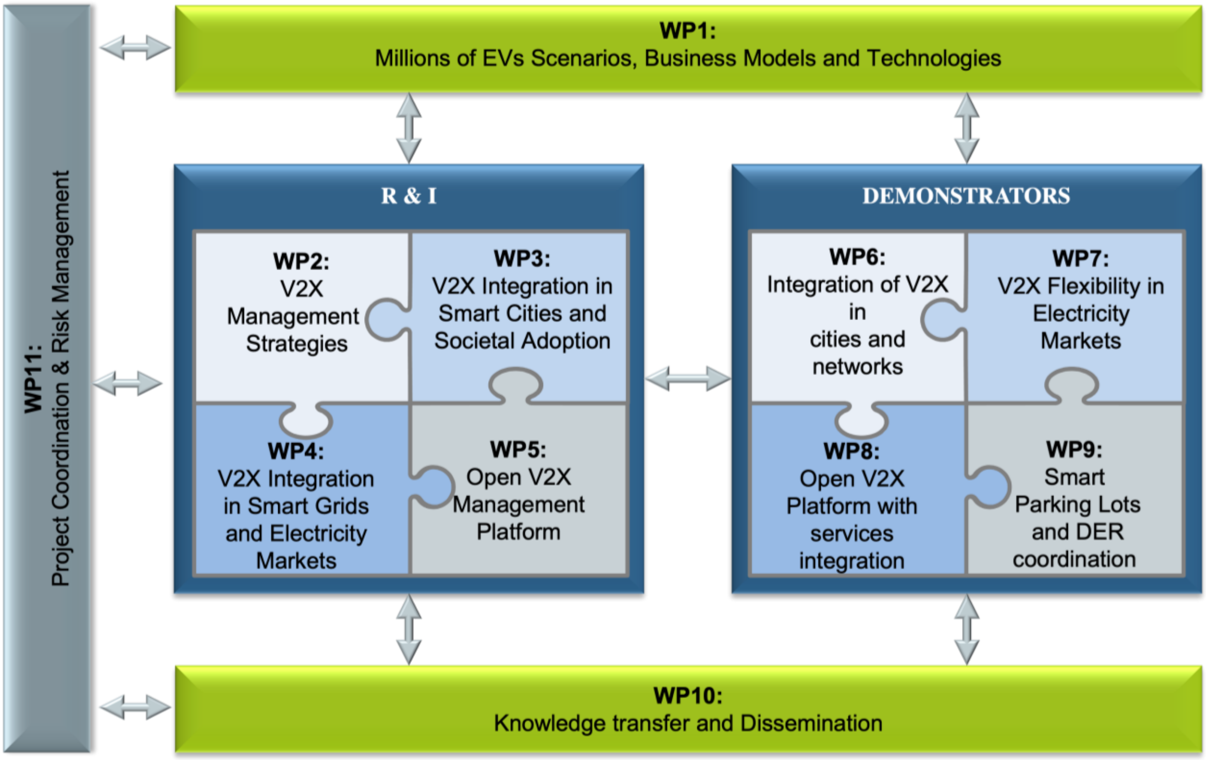

Figure 1 – EV4EU Work Packages Identification and Organization (from EV4EU grant proposal)

2 Data Management Plan

This Section outlines the Live DMP for the EV4EU project. The purpose of the DMP is to support the effective management of all research data collected, processed, and produced during the project's lifecycle.

The content of this document complies with the applicable legal framework, including Regulation (EU) 2016/679 of the European Parliament and of the Council (GDPR) [1], which repealed Directive 95/46/EC. It is also aligned with the Horizon 2020 programme guidelines, namely the *EC Directorate-General for Research & Innovation Guidelines on FAIR Data Management in Horizon 2020* and the *Guidelines on Open Access to Scientific Publications and Research Data* [2], [3]. Additionally, public metadata standards and tools have been adopted, such as those provided by the Research Data Alliance (RDA), the Metadata Directory from the Common European Research Information Format (CERIF), the disciplinary metadata frameworks developed by the Digital Curation Centre (DCC), and the Regulation (EU) 2023/2854 (Data Act), when and to the extent applicable regarding the interoperability of data [4], [5].

The DMP improves the transparency of the EV4EU project and its results by promoting its visibility, data, ensuring being findable and accessible in accordance with the FAIR principles (Findable, Accessible, Interoperable, and Reusable)

The EV4EU project is engaged in four demonstrations, whose data managers are listed below:

1. **Portuguese demonstrator:**

   Hugo Morais (hugo.morais@tecnico.ulisboa.pt)

   Cindy P. Guzman (cindy.lascano@tecnico.ulisboa.pt)

2. **Danish demonstrator:**

   Pietro Zunino: (pizuni@dtu.dk)

3. **Slovenian demonstrator:**

   Anton Cos: (anton.kos@electro-celse.si)

4. **Greek demonstrator:**

   Evangelos Karfopoulos: (e.karfopoulos@b2energy.gr)

2.1 Methodology on data collection for DMP

A structured data collection table was employed to support the developments conducted for the DMP across all pilots and demonstrators and *WP3 – V2X Integration in Smart Cities and Societal.* Moreover, data that were not directly generated but analysed within specific WPs, such as experimental results, validation datasets, and performance indicators from *WP1 – Millions EVs Scenarios, Business Models and Technologies, WP2 – V2X Management Strategies, WP4 – V2X Integration in Smart Grids and Electricity Markets, and WP5 - Open V2X Management Platform*, were also considered. These datasets played a crucial role in testing algorithms, validating models, and assessing the performance of proposed solutions under controlled or simulated conditions. This approach ensured that all datasets generated, reused, or analysed within the project complied with the FAIR principles and the Horizon Europe Open Science policy.

The process began with the identification of data sources, including technical measurements from the four demonstrators, outputs from simulation and co-simulation platforms, survey and interview data from societal studies, and information derived from external databases or previous research. In addition, data that were not directly generated but analysed within specific WPs were also considered. These datasets played a crucial role in testing algorithms, validating models, and assessing the performance of proposed solutions under controlled or simulated conditions.

Each dataset was characterised according to its purpose, origin, type, format, size, and utility, following a common metadata structure agreed upon within the consortium. A data reporting template and a shared *Data Definition Catalogue* (Excel format, stored on the EV4EU SharePoint) were used to standardise metadata collection and to support harmonisation and traceability across partners.

All partners were responsible for verifying the quality and integrity of their data, ensuring that ethical, legal, and confidentiality requirements were met. Sensitive or personal information was anonymised or aggregated prior to sharing. The technical coordination team consolidated and verified the coherence and completeness of all information before integration into the central DMP repository.

This comprehensive and traceable methodology ensured that both generated and analysed data were consistently documented, securely stored, and made available according to the project's governance framework and European Open Science standards, resulting in a harmonised and reliable dataset foundation for the EV4EU project.

2.2 Data Summary

2.2.1 Purpose of data collection and generation

The EV4EU project develops bottom-up, user-centric V2X management strategies to enable the large-scale adoption of EVs. These strategies address battery performance, user behaviour, power system integration, energy market participation, and the transformation of urban environments. Combining research, innovation, and large-scale demonstration, the project advances the integration of V2X technologies through smart management solutions, open platforms, and flexible energy systems, supporting Europe's transition towards sustainable and resilient electric mobility.

Different datasets contribute to achieving the EV4EU project objectives. In the early phase, data were gathered from stakeholders, experts, and local partners to identify user needs and operational requirements for electric mobility and flexibility services. The consortium analysed regulatory frameworks, energy system characteristics, and user behaviour to design interoperable, scalable, and user-focused smart charging and energy management solutions. In addition, collaborative methods were implemented to involve partners, regional energy authorities, and end users in the co-creation, implementation, and evaluation of demonstration activities, ensuring effective participation and knowledge exchange throughout the project.

Key findings were used to define the four large-scale Demonstrators for electric mobility integration. These include a suite of digital tools that use real data and simulation models to support decision-makers in assessing and predicting the technical and operational performance of charging infrastructures and flexibility services. Demonstrator characteristics, such as grid topology, user behaviour, and local renewable generation, are considered, as they strongly influence the design and operation of electric mobility systems. The modelling and analytical capabilities are continuously enhanced by the Demonstrator Partners, combining data from multiple sources, including IoT devices, charging platforms, grid monitoring systems, and user applications, to ensure accurate and up-to-date information throughout all project phases. The different software components are integrated and validated within each Demonstrator site, where EV4EU tests specific use cases and scenarios for smart and sustainable mobility.

Overall, EV4EU generates a wide range of new data products through modelling, simulation, and field demonstrations and WP3 – V2X Integration in Smart Cities and Societal Adoption, which can be classified into the following categories:

- Expert and stakeholder inputs, collected through interviews and surveys to define system requirements, identify user needs, and capture perceptions related to e-mobility, charging behaviour, and V2X adoption.
- Spatial and electrical network data, including LV/MV grid topologies, georeferenced substations, and infrastructure metadata used across the national demonstrators for planning, co-simulation, and flexibility analysis.
- In-situ and operational measurements, obtained from smart meters, EV chargers, batteries, and local monitoring systems at demonstration sites, enabling the collection of real-time and historical data on power, voltage, current, frequency, and environmental conditions.
- Models, algorithms, and co-simulation tools, developed to provide predictive intelligence, optimise charging and discharging behaviour, and support decision-making regarding flexibility activation and electric vehicle supply equipment (EVSE) deployment across all pilots.

2.2.2 Existing input data

The EV4EU project relies on existing datasets from project partners and external sources, including Distribution System Operator (DSO) network topologies, operational and meteorological data, and open-access charging datasets. Previous surveys and interviews on e-mobility behaviour also serve as inputs for socio-technical analyses. These data provide the foundation for modelling, co-simulation, and optimisation activities across all demonstrators.

2.2.3 Type and format of data

EV4EU manages both quantitative and qualitative data, including static metadata, real-time and historical measurements, simulation outputs, and survey results. Data are primarily stored in SQL databases (MariaDB, PostgreSQL, Apache) [6], [7], [8] and Excel or CSV formats, with qualitative notes in text or PDF files. Standardised vocabularies and metadata ensure consistency across demonstrators, and all formats are interoperable with modelling and co-simulation tools.

2.2.4 Data size

The total data volume generated within EV4EU varies across demonstrators and work packages. Survey datasets remain around 401 946 500 while real-time and historical measurement data can reach tens of bytes 3 616 722 531 bytes per day depending on sensor frequency and site occupancy. Overall, the expected cumulative size across all pilots and modelling tools is in the order of a few hundred gigabytes, stored in secure institutional databases and project repositories.

2.2.5 Data origin

Data used and generated within EV4EU originates from multiple sources:

- **Real measurements** from pilot sites, including EV chargers, Battery Energy Storage System (BESS), meters, and local sensors.
- **Technical datasets** provided by DSOs and research partners, such as LV/MV network topologies and substation parameters.
- **Simulation and forecasting outputs** produced by project models and co-simulation platforms.
- **User and expert surveys or interviews** conducted by SEL across all participating countries.
- **Open-access datasets**, including charging and energy profiles from repositories such as ACN-Data.

2.2.6 Data utility

The data collected and generated within EV4EU are essential for analysing grid flexibility, optimising smart and bidirectional charging strategies, and validating co-simulation and forecasting models. They also support socio-technical research on user behaviour and perceptions, providing evidence for policy, market design, and large-scale EV integration strategies across all demonstrators.

2.3 FAIR data

EV4EU follows the FAIR principles to ensure that all datasets are Findable, Accessible, Interoperable, and Reusable. Data are systematically documented with metadata and stored in structured databases (SQL, CSV, XLSX) accessible through secure institutional repositories and project platforms. Standard vocabularies and open APIs facilitate interoperability across demonstrators and modelling tools. Only anonymised and non-confidential data will be shared publicly, ensuring both scientific reusability and GDPR compliance.

2.3.1 Making data findable, including metadata

All EV4EU datasets are organised with consistent naming conventions and stored in structured databases to ensure traceability and easy retrieval. Metadata are created for each dataset following standard descriptors (source, ownership, type, temporal and spatial scope, format, and access level) and are linked through internal catalogues and open APIs. Publicly shareable datasets will include searchable metadata entries within the project website and institutional repositories, ensuring visibility and long-term accessibility.

To enhance findability and interoperability, all public datasets are uploaded to the EV4EU community in Zenodo, connected to the European Commission Funded Research (OpenAIRE) portal. Each dataset is assigned a persistent identifier (DOI) and enriched with metadata containing the Grant Agreement number, Project Acronym, Work Package, Task Leader, version, date, file type, DOI, description, access conditions, license, associated publications, and keywords.

Keywords are descriptive and aligned with EV4EU's research scope, including *Electric Vehicles, V2X Management, User-centric Management, Distribution Networks, Power Systems, and Smart Cities*. Publicly shareable datasets and their metadata will remain searchable through the project website, Zenodo, and institutional repositories, ensuring long-term visibility, accessibility, and compliance with FAIR principles.

To make the data findable and easily accessible by consortium partners during the project lifetime, a dataset catalogue was prepared and deployed in the EV4EU SharePoint cloud-based collaborative platform. The catalogue, structured as an Excel table, provided an overview of all datasets collected, reused, or generated across WP3 and demonstrators. Each partner was responsible for updating the table with information on their respective datasets, including key metadata such as dataset title, description, source, ownership, data type, format, and access conditions.

Table 1: Data Description Template

Category	Content
Type of data element	Indicate if data are static, measurements, forecasts, schedules, or surveys/interviews.
Consistent name	Provide the data name standard name for traceability.
Data utility	Describe briefly how the data support project objectives.
Purpose and relevance of data element in relation to objectives	Explain why the data are important for achieving project goals.
Methodology to produce the data element	State how the data were collected or generated.
Source and ownership	Identify where the data come from and who owns them
GDPR compliant	Confirm compliance and indicate if personal data are included.
Data format	Specify file type (e.g., SQL, CSV, XLSX, PDF).
Size	Estimate approximate data volume.
Vocabulary	Mention any controlled terms or standards used.
Storage	Indicate where and how the data are stored.
Security and privacy considerations	Note protection measures (passwords, encryption, anonymisation).
Dissemination level, limitations, license	Define access level and any usage restrictions.
Metadata available (Yor N)	State if metadata exist and which standard applies.
Notes	Add any relevant remarks or specific details.

2.3.2 Making data accessible

Data is made accessible by ensuring it can be retrieved online through standardized and secure protocols, in compliance with Horizon Europe's open data principles.

All EV4EU public data are deposited in trusted repositories, primarily in the EV4EU community on Zenodo, linked to the European Commission's OpenAIRE platform. Zenodo hosts open datasets, deliverables, and scientific publications, each associated with a persistent identifier (DOI) to guarantee traceability and long-term accessibility.

In addition, data is managed across several complementary systems operated by project partners:

- **Project Public Website** (https://ev4eu.eu): serves as the main public interface of the project, providing open access to key resources and outputs, including deliverables, publications, and dissemination materials available in the Resources section. The website ensures visibility and accessibility of project results and will remain online for at least five years after project completion, supporting long-term knowledge sharing and transparency.

- **Project Private Repository (SharePoint/Teams)**: used for internal sharing of documents, datasets under processing, and metadata not publicly available.
- **Project Open Data Repository (Zenodo)** (https://zenodo.org/communities/ev4eu/records): the main system for publishing final public datasets, media, and references to open-access publications or software.
- **Project Code Repository (GitHub)** (https://github.com/EV4EU): used to manage and share open-source software developed within the project.
- **Publisher and CORDIS sites** (CORDIS link): official platforms hosting peer-reviewed publications and project summaries .

The EV4EU SharePoint cloud-based platform ensures secure internal collaboration. Each dataset is identified by a unique internal reference and includes metadata aligned with the DMP structure. Data sharing specifications are defined collaboratively among partners, and open access is promoted whenever possible. However, access restrictions apply to datasets containing personal, sensitive, or proprietary information, particularly those from DSOs or user-related measurements.

Metadata are stored in the internal EV4EU dataset catalogue, accessible to consortium partners and accompanying any public dataset released. All metadata are formatted according to open, machine-readable standards to ensure interoperability, visibility, and long-term preservation.

Datasets identified as IPR-protected for patenting are excluded from open access and securely stored in private institutional repositories, ensuring confidentiality and compliance with intellectual property management rules.

2.3.3 Making data interoperable

Data interoperability within EV4EU is ensured using standardized formats, protocols, and vocabularies across all demonstrators and work packages. Datasets are structured in common formats such as SQL, CSV, and XLSX, with metadata aligned to the internal DMP catalogue. Interoperability between charging systems, energy management platforms, and simulation tools is achieved through internationally recognized protocols, OCPP (Open Charge Point Protocol) for EVSE communication, IEC 61851 and IEC 63110 for charging interface standards, and ISO 15118 for V2X data exchange. Controlled vocabularies and harmonized naming conventions further guarantee seamless data integration, reuse, and cross-demonstrator comparability.

2.3.4 Increased data re-use

EV4EU promotes data re-use by adopting standardized formats, interoperable protocols, and detailed metadata to ensure long-term accessibility and integration across demonstrators. Data collected from EV charging, grid operation, and user behaviour is anonymised, structured, and stored in shared repositories to enable comparative analysis and model validation. Re-use is encouraged within the consortium for simulation, forecasting, and optimization activities, while public deliverables provide aggregated results for external stakeholders. All reusable datasets follow FAIR principles and include clear licensing and access conditions.

2.3.5 Allocation of data resources

During the project, the EV4EU SharePoint cloud-based collaborative platform was adopted to store and share datasets and documentation among partners. No additional costs are foreseen for long-term deposit or preservation of public data, as these will be made available through institutional repositories, ensuring accessibility beyond the project lifetime.

Each dataset is managed by its creator or responsible partner, typically the task leader directly involved in data collection or generation. The internal data catalogue includes information on the corresponding work package, partner in charge, and contact person for each dataset. INESC-ID coordinates the overall data management framework and supervises the DMP implementation and supports documentation and metadata maintenance throughout the project lifecycle to ensure data consistency, compliance, and traceability.

2.3.6 Data security

Data security in EV4EU is ensured through controlled access, encrypted storage such as HS265, and strict GDPR compliance. All datasets are hosted on secure institutional servers and the EV4EU SharePoint platform, both protected by password authentication and access rights defined per partner. Sensitive and personal data are anonymised before sharing, and backups are regularly performed to prevent data loss. Each partner follows its institutional cybersecurity policies, ensuring data integrity and protection throughout the project lifecycle.

2.3.7 Data preservation

Data preservation in EV4EU is guaranteed through secure storage and long-term retention strategies. All datasets and metadata are archived in the EV4EU SharePoint platform and institutional repositories managed by the partners. Publicly shareable data, including aggregated results and deliverable annexes, will remain accessible through the EV4EU website (5 years from the end of the project) and open repositories after project completion. Partners ensure regular backups, version control, and maintenance of data integrity, following institutional and EU open data preservation standards.

2.3.8 Data access control

Access to EV4EU data is managed through a role-based permission system within the SharePoint collaborative platform and institutional servers. Each partner has restricted access to datasets relevant to their tasks, while INESC-ID oversees global permissions and repository administration. Sensitive and personal data are accessible only to authorised personnel under confidentiality agreements. Public access is granted exclusively to anonymised or aggregated datasets released through the EV4EU website or open repositories, ensuring both data protection and transparency.

2.3.9 Personal data

EV4EU handles personal data strictly in compliance with GDPR. Personal information is limited to user registration details, survey responses, and interview records collected under informed consent, in full respect of principles of purpose limitation and data minimisation. No special categories of data are processed. All personal identifiers are pseudonymised or anonymised before analysis and storage. In the case of pilot users, this is ensured by assigning each participant a unique internal ID within the platform, meaning that real names or direct identifiers are never used in any dataset handled for analysis or reporting. Access to such data is restricted to authorised project members, and processing is carried out solely for research purposes defined within the project scope. No personal data are transferred outside the EU or used for commercial purposes.

2.3.10 Data ethics

All data-related activities in EV4EU follow the highest ethical standards and comply with EU and national regulations. Data collection, processing, and sharing are conducted transparently, respecting participants' rights, privacy, and informed consent. Ethical considerations are integrated into all stages of the project, particularly in surveys and interviews involving human participants. The consortium ensures that data use serves only research and innovation purposes, avoids any discriminatory profiling, and upholds integrity, fairness, and accountability across all demonstrators and work packages.

2.3.11 Recommendations on data

Based on the data management practices established in EV4EU, it is recommended to maintain the current framework of secure storage, standardised metadata, and controlled access through the SharePoint repository. Future projects should continue adopting interoperable formats (SQL, CSV, XLSX) and standard protocols (OCPP, IEC, ISO) to ensure data compatibility and reuse. Regular updates of the dataset catalogue, anonymisation procedures, and GDPR compliance checks are essential to preserve data integrity and transparency. Promoting open access to aggregated and non-sensitive data will further enhance scientific collaboration and innovation impact.

3 Four demonstrators Data

This section presents all details regarding the data generated and managed during the implementation of the four EV4EU demonstrators, located in Portugal, Denmark, Slovenia and Greece. It describes the types of data collected, their purpose, methodologies, storage, and access conditions. These datasets encompass static infrastructure information, real-time and forecast measurements, user interaction data, and survey results, providing the empirical foundation for testing and validating innovative V2X-based grid services across diverse European contexts.

3.1 Purpose of the data collection and generation

The primary data sources derive from the four demonstrators implemented in Portugal, Greece, Slovenia, and Denmark, each addressing specific technical, and contextual challenges. The Portuguese demonstrator (São Miguel, Azores) focuses on household, building, and company-level V2X applications within a semi-isolated power system. The Greek demonstrator (Mesogia, Attica) validates an open V2X management platform for public charging and grid flexibility. The Slovenian demonstrator (Krško and Elektro Celje) analyses EV aggregation impacts on network operation and market participation. The Danish demonstrator (DTU Risø and Campus Bornholm) tests coordinated smart-charging and renewable integration through advanced energy management frameworks. To identify the datasets suitable for sharing and publication on Zenodo and other repositories, the data management team collaborated with the respective demonstrator leaders. Detailed dataset descriptions and data status summaries are presented in the following subsections.

3.2 DMP data collection and evaluation approach

3.2.1 Portuguese demonstrator

3.2.1.1 Pilot Status

The Portuguese demonstrator, implemented on São Miguel Island (Azores), integrates multiple data generators, including smart meters, photovoltaic systems (PVs), BESS units, EV chargers, and user interfaces deployed in houses, buildings, and companies. Its approach applies V2X strategies within a semi-isolated power system to enhance grid flexibility, energy resilience, and user participation. Data from real users, energy meters, and local weather sources are collected to support predictive models and control algorithms, encompassing electrical measurements (power, voltage, current, frequency, energy), EV charging sessions, state of charge (SoC) levels, weather conditions, and user feedback surveys.

3.2.1.2 Data description for the Portuguese Demonstrator

- **Static Data:** it contains the foundational metadata that describe the physical assets, contractual parameters, and technical configurations of each pilot sites. This dataset includes information from individual households (Houses 1–6), user attributes such as e-mail, password, and associated vehicles securely encrypted, as well as records from a building and a corporate site in the Azores. Each entry contains DSO contract details and technical specifications of the relevant assets, including meters, PV units, charging points (CPs), connectors, EVs, and BESS units. All static data are stored securely in a MariaDB SQL database, with access protected by authentication mechanisms and fully compliant with GDPR requirements. The information is classified as personal, sensitive, and confidential, and is used exclusively for modelling, simulation, and operational management within the project. Metadata are available through an open API interface for interoperability purposes.

- **Measurement data:** Measurement data comprise both historical and forecasted information collected from sensors, smart meters, and management platforms across the pilot sites. Historical data include electrical measurements (power, voltage, current, frequency, energy), EV and battery state of charge, weather conditions (solar radiation, wind speed, temperature), energy prices, and charging session records. These datasets enable detailed analysis of user behaviour, load profiles, and the interaction between EV charging and renewable generation. Forecasted data are generated by INESC ID using predictive models for power production, EV energy consumption, site demand, weather, and price evolution. This predictive layer supports the development of optimisation and control algorithms that enable flexibility services such as peak shaving, demand response, and renewable integration. All measurement data are stored in the same secure MariaDB infrastructure, ensuring privacy and data integrity across all collection and forecasting stages.
- **Scheduling data:** Scheduling datasets define the planned charging and discharging power profiles for EVs and BESS at each site. These data are produced through optimisation algorithms that calculate time-dependent power setpoints to meet user preferences, minimize energy bills, and grid objectives. They play a key role in validating smart-charging strategies and bidirectional operation (V2X) under real conditions. As with other data categories, scheduling information is stored in MariaDB, protected under the same privacy and security framework, and available via the project's open API.
- **Surveys and qualitative data:** Complementing the technical data, the Portuguese demonstrator also collects user-centred information through online surveys and interviews. These include quick and monthly satisfaction surveys conducted via survey and Qualtrics platforms, as well as in-person or remote interviews performed by SEL, EDA, and DREN. The objective is to measure user satisfaction, behavioural patterns, and overall experience with the demonstrator. Survey data are stored in Excel or text formats, available in Portuguese and English, and only disseminated after anonymisation and analysis to ensure GDPR compliance. Keywords associated with these datasets include *EV usage, demo experience,* and *user satisfaction*.

Together, these datasets provide a comprehensive foundation for analysing the technical performance, user engagement, and flexibility potential of the Portuguese EV4EU demonstration. The structured collection and secure handling of both static and dynamic information ensure compliance with ethical and legal standards while enabling valuable insights for future large-scale EV integration.

3.2.2 Danish demonstrator

3.2.2.1 Pilot Status

The Danish demonstrator, implemented at the Technical University of Denmark (DTU) Risø facility and Campus Bornholm (Rønne, Bornholm), integrates controllable EV charging infrastructure with building and parking-lot energy management systems, supported by local PV units and behind-the-meter services. The approach tests four user-cases: V2X in parking lots, V2X in buildings, demand-response and flexible-capacity contracts, and DSO-activated V2X services, all aimed at coordinating EV charging with renewables, grid services, and user behaviour. Data are collected in real-time and historically at the Point of Common Coupling (PCC) and individual plug level, including active/reactive power, voltage, current, frequency, total harmonic distortion, plug state, energy delivered, user inputs such as expected departure time and energy need, and priority algorithms. Metadata on charging-station assets (maintenance schedule, service actions) is also gathered. All data are stored securely (via hub.energydata.dk, DBMS, and password-protected systems), comply with GDPR, and are prepared for publication only after anonymisation and analysis.

3.2.2.2 Data description for the Danish Demonstrator

- **Static data:** Static datasets describe the physical infrastructure of the demonstration site. They include technical and maintenance information for the EV charging stations located at Campus Bornholm, such as service actions, maintenance schedules, and configuration details. These data are automatically extracted from system logs and stored in Excel or PDF format within a password-protected database. The data are internal, non-sensitive, and limited to infrastructure descriptions, no personal data are collected. Metadata are exposed through an open API to facilitate system interoperability and integration with project partners.
- **Dynamic data:** The core of the Danish demonstrator's dataset consists of high-resolution dynamic data measured at the PCC and at individual EV plugs. These datasets are used to monitor and control active and reactive power, voltage, current, frequency, and total harmonic distortion (THDI/THDV) under both grid-connected and charging states. The data also include reference values such as reference power for the PCC of the cluster, which defines the real-time power reference from the building or renewable generation to the EV cluster, as well as the power reference for the EV plug, specifying individual plug setpoints according to user preferences or system priorities. All measurements are stored as CSV files on hub.energydata.dk, using secure password-protected access. The datasets are internal to the project and only released for publication after being processed to remove any sensitive information.

  Several dynamic datasets capture the interaction between the system and the end users. These include variables such as expected departure time, requested energy, energy charged, and number of phases used. Each of these parameters contributes to the definition of charging priority, which is computed dynamically based on the user's time and energy requirements. Additional status indicators describe the communication and operational states of the charging system, including the state of the plug, which codes the plug's connection or charging status, and the representation of the internal state of the charging control algorithm. These data form the basis for validating smart-charging logic and control algorithms implemented by DTU. All user-related inputs are treated with strict confidentiality and comply fully with GDPR regulations.

  Complementary datasets include system-level operational parameters such as signal strength, measured from the charger's internal modem, to support troubleshooting and ensure reliable communication between EVSEs and the control platform. These measurements are also stored in CSV format on hub.energydata.dk with restricted access.
- **Surveys and qualitative data:** to complement the technical measurements, a quantitative survey was conducted for demonstration participants to assess satisfaction and user experience. Managed by SEL, the survey conducted online (in English) between May and August 2025 through the Survey platform. Data was stored in Excel format, password-protected, and analysed before any public dissemination to ensure privacy and data protection.

In summary, the Danish demonstrator generates a comprehensive multi-layered dataset encompassing infrastructure metadata, electrical and communication measurements, and user-related variables. Together, these data support the validation of advanced control algorithms for smart and bidirectional charging, provide empirical insights into EV-grid interaction, and contribute to scientific publications on energy flexibility and real-time optimisation within the EV4EU framework.

3.2.3 Slovenian demonstrator

3.2.3.1 Pilot Status

The Slovenian demonstrator, implemented in the regions of Velenje and Krško in partnership with the DSO Elektro Celje, explores the integration of electric EVs into the local distribution grid to *actively provide grid-flexibility and ancillary services*. The project collects detailed assets and network topology data, covering low- and medium-voltage (LV/MV) lines, substations, feeders and connection points, alongside high-frequency historical electrical measurements (power, voltage, current, reactive power) from secondary substations. Forecasted weather and load datasets support co-simulation of EV charging, renewable generation, and flexibility interventions. In parallel, user-centric surveys and interviews capture EV drivers' behaviour, preferences and V2X readiness. Additional demonstrator in Ljubljana had been integrated, which purpose was to be testing the prototype charging stations and compatibility of them to different EVs. At Ljubljana demo additional data had been collected. All data are managed under GDPR-compliant protocols, stored securely in institutional repositories, and publicly released (anonymised) in open-access platforms following project analysis.

3.2.3.2 Data description for the Slovenian demonstrator

- **Static data:** Static datasets include detailed LV/MV network topology models for both Velenje and Krško. These data provide the geospatial and electrical structure of the grid, covering lines, nodes, and substations, used for planning, power flow simulations, and flexibility assessments. The datasets were extracted directly from the DSO's Geographical Information System (GIS) database, cleaned, and organised into attribute tables that preserve network connectivity. They are stored in XLSX format following standard GIS terminology and remain confidential under a proprietary license, accessible only to the DSO. Metadata are available for each site to ensure traceability and structured integration into the project's analytical tools.
- **Measurement data:** The pilot collects both historical and forecasted measurement data relevant to grid operation and renewable generation. Electrical measurements include power, voltage, current, and reactive power values for devices across the Velenje and Krško areas. These data are measured directly by the DSO and recorded using Device Language Message Specification (DLMS) and Companion Specification for Energy Metering (COSEM) protocols [9], [10], ensuring compatibility with smart metering systems. Weather data include solar irradiance and temperature values measured by the national meteorological service ARSO, complemented with additional forecasts from ARSO. These datasets are essential for modelling photovoltaic production and predicting local generation and demand patterns. All measurement data are securely stored in Apache SQL/Lambda databases, password-protected and fully GDPR-compliant. Data from electrical measurements are considered personal and sensitive due to potential association with specific sites, while weather data are public and openly accessible. Electrical measurements include power, voltage, current, and reactive power values, as well as charging stations' status data, were also gathered for the Demo in Ljubljana. The data was collected from GEN-I's internal systems and archived. The data follow the same secure storage and protection framework as the data collected by the Elektro Celje. All data were stored in secure institutional repositories (GEN-I, SharePoint) in structured formats.

- **Forecasted data:** Forecast datasets extend the real-time measurements with predictive information on weather and electrical behaviour. Generated by Elektro Celje, these forecasts are crucial for proactive grid management, enabling scenario simulations, demand prediction, and flexibility activation. The data follow the same secure storage and protection framework as historical measurements, ensuring continuity and reliability across the data lifecycle.
- **Surveys and qualitative data**: To complement the technical datasets, qualitative interviews were conducted with demonstration users to capture feedback on satisfaction, usability, and perceptions of EV participation in the flexibility schemes. Conducted by SEL and GEN-I, the interviews took place between May and August 2025, either remotely or in person, and were stored as text notes in English or Slovenian. The information was password-protected and saved on secure project platforms (personal computers and SharePoint). Once analysed and anonymised, the results were publicly disseminated to share insights on user engagement and acceptance.

In summary, the Slovenian demonstrator's data architecture integrates geospatial network models, real-time and historical measurements, and predictive datasets to evaluate flexibility and renewable energy use in active distribution networks. Combined with user feedback, these datasets provide a comprehensive framework to assess how EVs can support grid stability and decarbonisation goals within the Slovenian power system. No personal or sensitive data were collected; all analyses relied solely on technical and aggregated information for system-level planning and validation.

3.2.4 Greek demonstrator

3.2.4.1 Pilot Status

The Greek demonstrator, located in the Mesogia area of Attica (with pilot activities in Koropi) and coordinated by Public Power Corporation (PPC) and Hellenic Electricity Distribution Network Operator (HEDNO), demonstrates the deployment and use of the open V2X management platform (O-V2X-MP) for public EV-charging infrastructure. The Pilot focuses on two primary business use-cases: Green Charging, which aligns EV charging to renewable-energy availability and grid conditions by using DSO-provided tariff and congestion signals, and Flexible Capacity Contracts, whereby the DSO requests charging/discharging setpoints to manage aggregated EV demand under network constraints, ensuring equitable access among users. Datasets cover a broad range of technical, operational and user-centric dimensions, from charging station metadata (CP1 – CP8), to real-time session logs via OCPP and API signalling, through to user authentication, virtual wallets and behavioural surveys. Data are captured from the charging infrastructure, the LV/MV network monitoring system and external data feeds, stored securely in PostgreSQL databases [8], and treated under GDPR and confidentiality protocols. Anonymised and aggregated data will be released to open repositories in accordance with FAIR principles to support replicability and market-model transfer across Europe.

3.2.4.2 Data description for the Greek demonstrator

- **Static data:** it includes the technical specifications of the charging stations installed at the Koropi site (CP1–CP8). These records describe nominal power, charging mode, number and type of connectors, and geographical location. The information is manually provided by the asset manager through an online form integrated into the O-V2X platform. All data are stored in secure PostgreSQL databases, password-protected, and fully compliant with GDPR. Although most static data are non-personal and considered public, sensitive information such as device identifiers and site coordinates are handled with restricted access.

- **Real-time and operational data:** A major component of the Greek demonstrator concerns real-time and operational data that capture the dynamic functioning of the O-V2X ecosystem. These datasets include charging session details and the operational status of the CP1–CP8 stations, automatically exchanged via the OCPP protocol between the chargers and the O-V2X platform. Additionally, the platform generates non-OCPP operational logs that record system activities, data exchanges, and performance events. Real-time inputs are also received from external stakeholders, such as tariff profiles and grid power limitation signals transmitted by HEDNO through a dedicated API. These data streams enable the system to adapt charging behaviour and flexibility offers to network conditions and market signals. All information is stored in PostgreSQL databases with encrypted access. Charging session data are treated as confidential (shared only between PPC and the user), whereas aggregated network data are publicly accessible.
- **User data:** User-related datasets include personal and transactional information necessary for platform interaction. This comprises authentication data (e-mail, password), securely encrypted, and billing data associated with a virtual wallet offered to users upon registration. The wallet simulates energy transactions based on real-time market prices (from PPC) and grid tariffs (from HEDNO), incentivising participation in flexibility events. User data are strictly confidential, encrypted, and managed in full compliance with GDPR regulations.
- **Historical and training data:** To support forecasting and optimisation modules within the O-V2X platform, historical datasets of charging sessions are incorporated. These include anonymised records from the DEI Blue CPO backend system, containing data such as start and end times and energy delivered, as well as open datasets from the ACN-Data project (Caltech) [11] used to train and validate predictive algorithms. Both data sources are stored in XLSX format in secure file-based systems and accessed exclusively by authorised personnel. These datasets are fundamental for model calibration and performance evaluation.
- **Routing and navigation data:** The O-V2X platform includes a routing module that guides EV users to available charging stations. The tool dynamically generates routes using the Leaflet Routing Machine library and optionally integrates with Google Maps for live navigation. Data include distance, estimated travel time, and turn-by-turn directions, stored temporarily in JSON/GeoJSON format. Routing data are session-based, password-protected, and automatically deleted after logout, ensuring user privacy and minimal data retention.
- **Surveys and qualitative data:** To complement the technical datasets, qualitative insights were collected through interviews and online surveys with demonstration users, coordinated by SEL, HEDNO, and PPC. Conducted between May and August 2025, these activities assessed user satisfaction, perceived usability, and behavioural responses to smart-charging incentives. Results were stored as text notes (English/Greek) on password-protected computers and the project SharePoint. Once anonymised and analysed, the aggregated results were made publicly available.

Overall, the Greek demonstrator establishes a rich, multi-layered data architecture connecting user behaviour, network conditions, and platform performance. By combining real-time operational data, user interactions, and historical records, the pilot enables a comprehensive assessment of how bidirectional charging and flexibility services can be effectively deployed within the Greek energy ecosystem.

3.3 The Demonstrators Overall

The four EV4EU demonstrators collectively serve as real-world validation environments for user-centric and grid-supportive V2X strategies. Each demonstrator operates under distinct regulatory, geographical, and technical contexts, providing a comprehensive understanding of how smart and bidirectional charging solutions can enhance energy flexibility, grid resilience, and user engagement across Europe.

Data generated from the four pilots encompass both technical and behavioural dimensions, including electrical measurements, network topology and operational constraints, weather and market signals, and user-related feedback through surveys and interviews. This multi-layered data ecosystem enables the analysis of interactions among EVs, users, and energy systems, fostering interoperability between digital platforms and grid operators.

All demonstrators apply common principles for data collection, storage, and governance, following the EV4EU Data Management Plan structure and the FAIR guidelines. Each dataset is properly catalogued, traceable through internal metadata standards, and managed in compliance with GDPR and institutional ethics requirements. While data ownership remains with the respective national partners, harmonised data formats and shared ontologies ensure comparability and cross-demonstrator analysis.

Together, the demonstrators represent a coordinated European testbed for V2X technologies, contributing valuable empirical evidence to support large-scale EV integration, inform policy design, and accelerate the transition toward a decarbonised and flexible energy system.

4 Scenario Modelling and V2X Impact Assessment Data

This section presents the datasets and methodologies used to support scenario modelling and impact assessment activities across several EV4EU work packages and deliverables. The data underpin the analysis of electric mobility evolution, grid interaction, and V2X control strategies, forming a coherent framework that connects technical modelling with real-world system validation.

4.1 Purpose of the data collection and generation

The purpose of the data collection and generation in this section is to describe how diverse data were analysed and integrated to support the objectives of key EV4EU deliverables focused on scenario modelling, system analysis, and V2X impact assessment. This section highlights how data from multiple sources, such as national mobility statistics, energy system records, real operational measurements, and simulation results, were used to inform and validate the findings of different Work Packages: WP1 [12], [13], [14], WP2 [15], [16], [17], [18], [19], WP4 [20], [21], [22], [23], [24], and WP5 [25], [26], [27], [28], [29].

The co-simulation tool from WP3 Integrates operational and grid datasets (e.g., substation data from EDA in Portugal, consumption time series from Elektro Celje in Slovenia, and co-simulation outputs from INESC-ID) to support modelling, validation, and scenario development. These data underpin the co-simulation platform developed in *T3.4: Definition and Development of a City-Level Co-simulation Platform for V2X [30] and T3.5: Simulation of V2X Management Strategies at City Level [31],* enabling detailed analysis of grid capacity, EVSE placement, and infrastructure costs in cities such as Ponta Delgada, Krško, Rønne, and Mesogia.

4.1.1 Millions EVs Scenarios, Business Models and Technologies Data

This section presents the analytical activities carried out within three of the tasks of *WP1, which are: Millions EVs Scenarios, Business Models and Technologies*. Together, these tasks build the conceptual and analytical basis of the project by exploring large-scale electric mobility scenarios, assessing the systemic impact of V2X technologies on energy networks, and identifying the regulatory conditions that enable their integration. The work relies exclusively on secondary and institutional data sources, including literature reviews, statistical datasets, and regulatory frameworks, analysed to map future EV and V2X trends, business models, and technological pathways. The outcomes provide structured and descriptive knowledge that supports the definition of technical strategies and demonstrator implementations.

4.1.1.1 Description of Data – Task 1.1: Electric Road Mobility Evolution Scenario

Task 1.1 focused on developing electric mobility evolution scenarios to forecast the expected penetration of EVs and related charging infrastructure across the four EV4EU demonstration countries up to 2050, as described in Deliverable D1.1 [11]. The task relied on the collection, harmonisation, and analysis of quantitative data from multiple official and technical sources, including Eurostat, European Alternative Fuels Observatory (EAFO), national statistical institutes, grid operators, and energy and transport agencies. These datasets covered a wide spectrum of variables relevant to electric mobility, such as total vehicle stock, new registrations by fuel type, fleet electrification rates, population and GDP trends, energy mix, electricity price evolution, and renewable energy integration levels.

In addition to statistical data, the analysis integrated sectoral modelling results from European reference scenarios (e.g., PRIMES-TREMOVE, EU Reference Scenario 2020) and national policy roadmaps describing future decarbonisation targets, emission reduction goals, and transport electrification pathways. Data were processed and aggregated using consistent temporal (annual) and spatial (national) resolutions, ensuring comparability among countries.

The resulting datasets were used to construct three EV adoption trajectories, Baseline, Moderate, and Accelerated, each representing different assumptions regarding policy ambition, technology maturity, and infrastructure deployment. These trajectories quantify expected EV numbers, energy consumption, charging demand, and greenhouse gas emission reductions over time.

All datasets were stored in structured Excel and CSV formats, with metadata specifying data origin, year, resolution, and reliability. The processed information provides the foundational analytical layer for subsequent tasks, notably T1.2, where the scenarios were used to evaluate power system impacts, and WP3, where they served as inputs for the co-simulation platform to assess spatial planning and grid flexibility requirements.

4.1.1.2 Description of Data – Task 1.2: Impact of V2X in Energy and Power Systems

Task 1.2 assessed the large-scale integration of EVs and their potential impact on energy and power systems in the four EV4EU demonstration countries under different time horizons (2030, 2040, and 2050). The analysis relied on a wide range of quantitative and model-generated datasets, integrating energy demand and generation profiles, EV adoption trajectories from Deliverable D1.1 [11], and national policy targets for renewable energy expansion and decarbonisation.

The core data used for this task included:

- National electricity demand and generation datasets derived from public operators and energy agencies (e.g., ENTSO-E, REN, ELES, Energinet, HEDNO), covering hourly power demand, renewable and non-renewable generation, and interconnection capacities.
- EV parameters and mobility data, such as fleet size projections, average travel distances, charging location preferences, and user behaviour patterns, obtained from national statistics, mobility reports, and EU reference scenarios.
- Synthetic data generated by modelling tools, including daily EV load profiles and temporal charging patterns derived through probabilistic methods (gamma and normal distributions) that represent typical household, workplace, and public charging behaviours for each country.

All datasets were harmonised into comparable temporal and spatial resolutions and structured into country-specific simulation inputs. A simulation platform was developed to evaluate EV energy demand and grid impacts, incorporating several V2X management strategies: Time-of-Use (ToU) tariffs, Real-Time Pricing (RTP), peak-shaving schemes, and renewable-energy coordination mechanisms. These strategies were tested through simulation scenarios using the highest consumption day of 2021 as a baseline, projecting the evolution of electricity demand up to 2050.

The analysis produced derived data in the form of power demand curves, EV charging/discharging profiles, and indicators of system stress, renewable utilisation, and emission reduction potential. Results were stored in structured Excel and CSV files with descriptive metadata documenting data sources, temporal coverage, modelling assumptions, and country context.

The data from Deliverable 1.2 [12] serve as the analytical bridge between scenario modelling and system validation, directly informing the design of V2X management strategies in WP2 and providing boundary conditions for the co-simulation platform developed in WP3.

4.1.1.3 Data Description – Task 1.3: Regulatory opportunities and barriers for V2X deployment in Europe

This task did not involve the collection of primary or personal data. Instead, it relied on the systematic review and analysis of secondary data sources, mainly European and national legislation, regulatory frameworks, and official public documents, to identify existing opportunities and barriers for V2X deployment across Europe, as described in Deliverable D1.3 [13]. The analysis covered four main thematic areas (energy policy, EV and charging infrastructure, distributed energy resources (DERs) and market design, and data security and privacy). All data were obtained from publicly available sources (e.g., EUR-Lex, national gazettes, mobility regulations) and were used exclusively for analytical and comparative purposes. No personal or sensitive information was processed, and the outputs consist of aggregated, textual summaries and regulatory mappings stored in standard document formats within the project repository (SharePoint).

4.1.2 V2X Management Strategies Data

This section covers the data-related activities developed under *WP2: V2X Management Strategies.* Together, these tasks provide the technical backbone of the project, focusing on the design, modelling, and validation of control algorithms that enable V2X functionalities across multiple environments, from individual households and buildings to parking lots, company fleets, energy communities, and grid-level services.

The work within WP2 involves both the use of real-world technical data (from demonstrator sites and institutional sources) and the generation of simulated datasets for testing and optimization. The analyses integrate physical measurements, forecasting modules, and optimization frameworks, including machine learning models and Mixed-Integer Linear Programming (MILP) formulations, to evaluate the performance of V2X-based flexibility services under different operational and market scenarios.

All datasets are technical and non-personal, consisting of structured time-series data, simulation outputs, and algorithmic parameters. They are securely stored in project repositories (SharePoint and GitHub) and serve as the analytical foundation for developing, validating, and demonstrating advanced V2X control and management strategies across the EV4EU project.

4.1.2.1 Data Description – Task 2.1: Control Strategies for V2X Integration in Houses

This task involved both the collection of operational technical data and the generation of simulated datasets to develop and validate a decision-making model for integrating V2X and DERs within Home Energy Management Systems (HEMS). The data sources included real measurements from Eletricidade dos Açores (EDA) (solar PV production, wind curtailment, congestion levels), household energy consumption from the Horizon 2020 SMILE project [32], tariff information from the Portuguese Energy Regulator (ERSE), and meteorological data from the National Solar Radiation Database (NSRD). Additionally, synthetic datasets were created to represent EV usage patterns, probabilistic load profiles, and participation in grid services. The data fed the model's three computational modules, forecasting (Random Forest), daily planning (Mixed-Integer Linear Programming using IBM CPLEX), and real-time operation. Simulation scenarios were parameterized and evaluated to assess cost, flexibility, and energy flow metrics, as described in Deliverable 2.1 [14]. All data and source codes were stored in structured formats within the project's secure GitHub repository. No personal or sensitive information was collected or processed.

4.1.2.2 Data Description – Task 2.2: Control Strategies for V2X Integration in Buildings

This task involved both the processing of real technical data and the generation of synthetic datasets to develop and test V2X and DERs control strategies in buildings, as described in Deliverable D2.2 [15]. The Portuguese demonstrator used real datasets from Eletricidade dos Açores, including building load profiles, solar PV production, and grid service data, complemented by anonymised EV charging sessions obtained from Instituto Superior Técnico (IST). The Danish site employed equivalent synthetic datasets. Additional information included network tariffs from EDA and ERSE, as well as meteorological data. Simulation scenarios covered uncontrolled charging, optimisation-based management, and grid service participation, producing quantitative outputs such as annual energy balance, cost reduction, and flexibility indicators, as detailed in Deliverable D2.2. The datasets were processed and stored in structured formats within the project's GitHub repository and internal SharePoint. No personal or sensitive data were collected, and all analyses relied exclusively on anonymised and aggregated information.

4.1.2.3 Data Description – Task 2.3: Optimal Management of V2X in Parking Lots

This task involved the collection, processing, and generation of technical and simulated data for developing and validating V2X control strategies in parking lot environments, as described in Deliverable D2.3 [16]. The Danish demonstrator (Risø and Campus Bornholm) provided real measurements of EV charging sessions, local PV generation, and grid connection parameters. Additional datasets included anonymised cluster power profiles from DTU Lyngby (Denmark) and PPC (Greece), used for forecasting using the Light Gradient Boosting Machine (LightGBM) model. Control and optimization modules were implemented in Python and Matlab Simulink to simulate scenarios such as grid limit compliance, DSO demand response, PV integration, phase unbalance correction, and frequency regulation. Communication delay parameters were experimentally measured to calibrate the distributed control architecture. All datasets and code were stored in structured formats within secure repositories. No personal or sensitive user data were collected; only aggregated and anonymised technical data were used for simulation and model validation purposes.

4.1.2.4 Data Description – T2.5: Integration of V2X in Energy Communities Management

T2.5 presents methodologies for optimizing the operation of energy communities that include EVs, BESS, PV units, generators, and controllable loads, as described in Deliverable D2.5 [18]. The study evaluates deterministic, stochastic, and metaheuristic optimization approaches implemented in the Python Energy Communities (PyECOM) platform, which simulates and manages energy flows across multiple assets and user profiles.

The datasets used comprise simulated technical parameters (load and generation profiles, PV production, battery capacity, and EV charging behaviour) combined with measured data from residential and commercial buildings in Portuguese islands. For stochastic simulations, probabilistic distributions were derived from quantile regression methods applied to historical data, generating 25 scenarios of combined load and generation uncertainty. Energy price signals were based on OMIE day-ahead market data.

The results demonstrate that deterministic and stochastic models achieve optimal management of community resources, balancing grid imports, BESS and EV operations, and renewable generation. The stochastic model additionally enables the scheduling of up and down power reserves using grid imports and BESS flexibility. In contrast, the metaheuristic model (Dandelion Optimizer) performs poorly under the analysed use case, highlighting the importance of accurate forecasting and robust optimization for community energy management.

The data generated and processed within D2.5 are numerical and simulation-based, stored in structured CSV and Python-readable formats within the secure INESC-ID and project SharePoint environments. These datasets support the quantitative assessment of energy community management strategies integrating V2X functionalities, serving as a foundation for further analysis in subsequent tasks and deliverable.

4.1.2.5 Description of Data – Task 2.6: Control Strategies for the Optimal Operation of Electrified Road Freight and Public Transport

Task 2.6 analysed quantitative and operational data related to the electrification of road freight and public transport fleets in Europe, with a specific focus on the EV4EU demonstration countries, as detailed in Deliverable D2.6 [17]. The main purpose was to design and validate data-driven control strategies for the optimal management of charging and discharging operations in heavy-duty vehicles (HDVs), including buses and garbage refuse trucks.

The datasets used combined real operational data, technical fleet parameters, and simulation-generated information. Empirical data were gathered primarily from Danish and Slovenian pilot projects involving public transport and municipal fleets, while contextual data on the status of heavy-duty fleet electrification were derived from European and national databases (e.g., ACEA, Eurostat, Greenpower Denmark, and local mobility agencies). The real-world datasets included bus fleet characteristics (battery capacity, charging power, route length, and idle times), operational energy usage, and state-of-charge (SoC) evolution, as well as truck fleet schedules and depot charging profiles obtained from Amager Resource Centre (ARC) in Copenhagen.

These datasets were processed using a techno-economic optimization framework developed by DTU and project partners (INESC-ID, EDP NEW, ABB, BEOF). The framework incorporated MILP models to evaluate different operational strategies for fleet charging management, such as unidirectional (V1G) and bidirectional (V2G and V2G + FCR-D) configurations. Data inputs included hourly electricity market prices from Nord Pool, tariffs from Energinet and Cerius, PV production and building consumption profiles from Campus Bornholm, and frequency containment reserve (FCR-D) volumes from the Danish TSO.

All input and output datasets were stored in structured CSV and Excel formats, including time-series of power flows, SoC evolution, energy consumption, and cost components. Derived data included optimization results such as total yearly energy costs, battery degradation indices, and fleet self-sufficiency metrics. Metadata documented the source, time resolution, and modelling assumptions.

4.1.3 V2X Integration in Smart Cities: Co-Simulation Tool Data

This section introduces the data management framework adopted for the co-simulation platform developed within WP3 of the EV4EU project. The platform serves as a collaborative environment that integrates models, datasets, and simulation tools from different domains, such as EV behaviour, charging infrastructure, and power system operation, to evaluate innovative flexibility services and control strategies. Given its multidisciplinary nature, effective data management is essential to ensure the consistency, interoperability, and reliability of the information exchanged among partners and simulation modules.

The following subsections describe how data are structured, stored, and shared within this platform, outlining the main procedures for metadata documentation, access control, versioning, and long-term preservation.

4.1.3.1 Co-simulation tool data description

WP3 integrates technical datasets supplied by DSOs and research partners for use in co-simulation platforms and system modelling:

- The "EDA CARE BT" dataset provides operational information from secondary substations in Ponta Delgada (Azores, Portugal), including location, rated power, and available capacity. The dataset is derived from public reports by EDA and is publicly available in PDF format.
- The "izvoz_RTP_Krško_v1" dataset contains time series of active and reactive power from secondary substations in Krško, Slovenia, provided by Elektro Celje through UL partners. This dataset supports validation of grid models and flexibility simulations.
- The "Topology Data Krško" dataset complements this by providing LV/MV network topology with geographic coordinates, rated power, and capacity limits for feeders and buses. Both datasets are stored in XLSX format on project SharePoint, are confidential, and accessible only to authorised consortium members.

These operational and topological datasets serve as the backbone for co-simulation of EV-grid interactions, allowing the evaluation of flexibility services and the spatial planning of charging infrastructure.

The WP3 co-simulation platform, developed under *Deliverable D3.4: Definition and Development of a City-Level Co-simulation Platform for V2X [29]* and validated in *Deliverable D3.5: Simulation of V2X Management Strategies at City Level [30]* by INESC-ID, produces structured outputs that guide the optimal siting of EV charging infrastructure across European demonstration regions.

- Results are available for Ponta Delgada (Portugal), Krško (Slovenia), Rønne (Denmark), and the Mesogia area (Greece). Each dataset includes geographic coordinates, number, rated power, and installation cost of proposed EVSE units based on multi-objective optimisation combining grid constraints, demand forecasts, and economic factors.
- The results are provided in Excel and PDF formats, stored on secure local devices and the EV4EU SharePoint, and are publicly available through the official Deliverable D3.5 on the EV4EU website. Sensitive details such as exact grid parameters are excluded from public versions to ensure confidentiality.

These simulation results directly support decision-making processes for charging infrastructure deployment, bridging the gap between system-level modelling and real-world demonstration.

4.1.4 V2X Integration in Smart Grids and Electricity Markets Data

This section summarises the data-related activities carried out within *WP4: Distribution and Transmission System Operation Strategies*. These tasks collectively focus on developing and validating planning, operation, and market strategies that integrate V2X flexibility into both distribution and transmission networks. The analyses rely exclusively on technical and simulated data, including network parameters, synthetic load and generation profiles, optimization results, and communication exchanges between grid operators, aggregators, and V2X resources. All datasets are non-personal, aggregated, and processed using mathematical and simulation models implemented in Python and

Matlab. The resulting data and models are stored in structured formats within secure institutional and project repositories, ensuring interoperability, traceability, and compliance with data protection principles.

4.1.4.1 Data Description – Task 4.1: Distribution Network Planning Strategies considering V2X Flexibilities

This task involved the processing and generation of technical and simulation-based data to develop new methodologies for distribution network planning that integrate V2X flexibility, as detailed in the Deliverable D4.1 [19]. Real charging and occupancy profiles from the public "My Electric Avenue" trials (UK, 2014–2015) were used as reference data to calibrate the EV flexibility model. Additional datasets were synthetically generated to simulate grid operation under high EV penetration, including time series of power flow, voltage, congestion events, and reliability indicators. The study produced quantitative outputs such as flexibility costs, energy not supplied (ENS), investment trade-offs, and grid reinforcement deferral metrics. All datasets and models were processed using mathematical formulations and simulation tools (Python, Matlab) and stored in structured formats within secure institutional repositories (INESC-ID and project SharePoint). No personal or sensitive data were collected; all analyses relied solely on technical and aggregated information for system-level planning and validation.

4.1.4.2 Data Description – Task 4.2: Scheduling and Real-Time Operation Strategies to Control V2X Flexibilities

This task involved the processing and generation of technical and simulation-based data to develop scheduling and real-time control strategies for managing V2X flexibility within distribution networks, as detailed in Deliverable D4.2 [20]. The study focused on two complementary mechanisms, Flexible Capacity Contracts (FCCs) and Variable Distribution Use-of-System (DUoS) Tariffs, aimed at enabling congestion management and efficient network operation. The datasets included synthetic load and generation time series, network parameters from a 47-node distribution grid (Greek demo), and behavioural models of EV charging aggregated by Charge Point Operators (CPOs). Simulation-based data were produced using bilevel optimisation frameworks in Python and Matlab to assess tariff efficiency, flexibility procurement costs, and operational performance. The outputs consist of quantitative indicators of grid flexibility, cost reduction, and congestion mitigation. All data and scripts were stored in structured formats secure project repositories (SharePoint, DTU). No personal or sensitive information was collected or processed; all datasets are technical, aggregated, and used exclusively for research and model validation purposes.

4.1.4.3 Data Description – Task 4.3: Integration of V2X in Charging Point Operators and Virtual Power Plants Aggregation

This task involved the generation and processing of technical and communication data to develop energy management algorithms for integrating V2X, renewable energy sources (RES), and BESS within CPO platforms and Virtual Power Plants (VPPs), as described in Deliverable D4.3 [21]. The work included defining the data exchange architecture between CPOs and the GEN-I aggregation platform using standard communication protocols (OCPP 2.1, ISO 15118-20, Modbus, IEC 61850, DNP3) and JSON-based telemetry messages. Synthetic datasets were created to model charging patterns, availability, and flexibility behaviour of aggregated EV fleets, which were used in stochastic optimisation problems to evaluate operational and market performance. The outputs consist of structured signal lists, activation messages, and performance indicators supporting the Slovenian demonstrator. All data were stored in secure institutional repositories (GEN-I, UL, SharePoint) in structured formats. No personal or sensitive information was collected or processed; all datasets are technical and non-identifiable, used solely for research and system-integration validation.

4.1.4.4 Data Description – Task 4.4: Impact of Mass Deployment of V2X in Energy Markets and Services

This task involved the processing and generation of simulation-based and statistical data to assess the large-scale integration of V2X technologies into energy markets and flexibility services, as described in Deliverable D4.4 [22]. The study combined statistical data from mobility and market reports (Eurostat, Borzen, ELES) with synthetic datasets representing EV charging behaviour, fleet growth projections, and participation in ancillary and local flexibility markets. The Slovenian demonstrator provided the operational context, using simulated communication data and service activation signals (mFRR, congestion management, voltage control, ToU optimisation, maximum power control) through the OneNet-based market platform. Quantitative indicators were generated to estimate system capacity requirements, flexibility potential, and market participation levels up to 2050. All datasets and models were developed and stored in structured formats within secure institutional repositories and project SharePoint. No personal, behavioural, or financial data were collected or processed; all analyses relied solely on aggregated, technical, and simulated information for market modelling and system-level evaluation.

4.1.4.5 Description of Data – Task 4.5: Demand Response Programs Design for EVs

Task 4.5 focused on the design, modelling, and validation of demand response (DR) programs specifically adapted to EV integration scenarios in Portugal, Greece, and Slovenia, as described in Deliverable 4.5 [23]. The work relied on the analysis of real operational datasets, provided under confidentiality agreements by local DSO project partners, combined with synthetic data generated from simulation models. The datasets were used to quantify flexibility potential, evaluate charging behaviour, and assess the technical and economic viability of DR schemes that could enhance grid reliability while supporting user participation.

The data analysed included aggregated EV charging sessions, household and building consumption time series, grid operational parameters (such as voltage, current, and transformer loading), and local renewable generation profiles. For Portugal, data were collected through EDA (Electricidade dos Açores) in the Ponta Delgada demonstrator; for Greece, data originated from PPC/HEDNO networks supporting the O-V2X platform; and for Slovenia, Elektro Celje provided LV/MV consumption and topology data from the Krško region. These datasets, all GDPR-compliant, were stored in structured Excel and CSV formats within the project's secure SharePoint and institutional databases, with restricted access due to their sensitive and proprietary nature.

The processed data were used to develop and validate country-specific DR models, integrating user profiles, price-responsive charging strategies, and technical constraints derived from the demonstrator systems. The outputs included flexibility availability curves, load-shifting potential, network impact indicators, and aggregated cost–benefit metrics. These derived datasets supported the definition of scalable DR mechanisms tailored to each country's grid conditions and regulatory framework.

Overall, the Task 4.5 datasets provided the empirical foundation for modelling and validating advanced EV demand response programs, demonstrating the operational feasibility and user acceptance of flexibility participation under real-world conditions, and serving as key inputs for future replication within WP5 and WP6.

4.1.5 Open V2X Management Platform Data

This subsection describes the data analysed and managed within the development of the Open V2X Management Platform (O-V2X-MP). The platform serves as a central framework for integrating, processing, and exchanging information between multiple actors, such as EV users, aggregators, DSOs, and energy service providers, to enable secure and efficient V2X interactions. Data collected and reused for this purpose include technical parameters from chargers and vehicles, network and market data, and interface specifications required for interoperability and standardisation. These datasets were used to design, test, and validate the platform's architecture, APIs, and user interaction modules, ensuring compliance with cybersecurity, privacy, and FAIR data principles.

4.1.5.1 Data Description – Task 5.1: Information Exchange Needs to Enable Different Use Cases

This task involved the collection and structuring of qualitative and technical information to map the data exchange needs and barriers among actors in the EV4EU demonstrators, as described in Deliverable D5.1 [24]. The analysis followed the IEC 62559-2 methodology to define information flows, message identifiers, and interoperability requirements for seven Business Use Cases (BUCs) covering market participation, demand response, curtailment management, and flexibility services. The datasets include standardized tables describing exchanged data objects, communication protocols, and operational requirements between DSOs, TSOs, Aggregators, CPOs, and end-user systems. The information was derived from partner inputs and public reports and stored in structured formats (.xlsx, .csv, .docx) within institutional and project repositories. No personal, behavioural, or sensitive data were collected or processed; all information is aggregated, descriptive, and used solely for defining interoperability specifications and the design of the Open V2X Management Platform.

4.1.5.2 Data Description – Task 5.2: Standardization Gap Analysis for New V2X-related Business Models

This task involved the systematic collection and analysis of technical and standardization data to identify communication gaps and interoperability barriers relevant to new V2X business models, as identified in Deliverable D5.2 [25]. The study reviewed existing standards and protocols, including IEC 61851, OCPP (1.6, 2.0.1), ISO 15118, IEC 63110, and CCS, and mapped their applicability to EV4EU use cases. The datasets consist of structured information on communication flows (EV–EVSE–CSMS), interoperability parameters, and message schemas, complemented by integration test data from OCPP-based charging management platforms. Analytical outputs include version comparison tables, standardization gap identification, and recommendations for protocol harmonisation. All information was processed in structured formats and stored in secure project repositories (PPC, INESC-ID, EDP NEW, DTU, SharePoint). No personal or sensitive data were collected or processed; all datasets are technical, descriptive, and used exclusively for interoperability assessment and standardization contributions.

4.1.5.3 Data Description – Task 5.3: High-level Design of Open V2X Management Platform (O-V2X-MP)

This task involved the generation and structuring of technical and architectural data to design the Open V2X Management Platform (O-V2X-MP), as described in Deliverable D5.3 [26]. The datasets include system specifications, interface definitions, and data models describing the interaction between Electric Vehicles (EVs), Charging Stations (EVSEs), Charging Station Management Systems (CSMS), and market entities (CPOs, DSOs, TSOs, VPPs). The platform design integrates communication protocols (OCPP 1.6/2.0.1, ISO 15118, IEC 61851, IEC 63110, OCPI, OICP) and defines backend and frontend requirements, including billing mechanisms, role-based access control, and API interfaces (Location, CDR, Tariff, CRM). Supporting data were generated through simulation and software testing, including JSON message exchanges, PCAP network captures, and UML-based entity relationship diagrams. All data were processed in structured formats and securely stored in institutional repositories (PPC, INESC-ID, UL, SharePoint). No personal, behavioural, or sensitive information was collected; all datasets are technical and non-identifiable, used solely for platform development, validation, and interoperability purposes.

4.1.5.4 Data Description – Task 5.4: Cyber-security and Privacy Analysis for V2X Services

This task involved the generation and analysis of technical and network security data to assess cyber-security and privacy risks associated with V2X communications and services, as described in Deliverable D5.4 [27]. The work focused on identifying potential attack vectors, evaluating GDPR-related data protection risks, and developing cyber-resilience mechanisms for the Open V2X Management Platform (O-V2X-MP). The datasets include communication logs, digital certificates, simulated intrusion events, and network traffic captures collected in a controlled testbed environment. Security tools such as Zeek (NIDS), Suricata, MISP, pfSense, and Graylog were used to detect, log, and mitigate simulated cyber-attacks. The analysed data are purely technical and anonymised, comprising message traces, authentication events, and encrypted exchanges under standard protocols (OCPP 1.6/2.0.1, ISO 15118, TLS, IPsec). All files were processed and stored in structured formats within secure institutional repositories (PPC, INESC-ID, SharePoint). No personal or sensitive data were collected or processed; all information is technical and used solely for security validation and platform resilience testing.

4.1.5.5 Data Description – Task 5.5: Open V2X Management Platform

This task involved the generation and processing of software, communication, and analytical data to implement the backend of the Open V2X Management Platform (O-V2X-MP), as described in Deliverable D5.5 [33]. The work included the development of microservice-based architectures, communication management using OCPP 1.6 and 2.0.1, cybersecurity mechanisms (TLS, JWT, HTTPS), and analytics modules for processing aggregated EV charging data. The datasets comprise JSON and WebSocket message exchanges, diagnostic logs, configuration files, and results from tests performed with the SAP e-mobility charging station simulator and ABB TAC-W22-T-R-C-04 chargers. Additional data include C4 architecture diagrams, REST API specifications, and outputs from embedded machine learning routines for clustering and transaction analysis. All data were processed in controlled environments using Python (Django, Celery, Sanic) and Docker and stored in structured formats within secure project repositories (PPC, INESC-ID, SharePoint, GitHub). No personal or sensitive data were collected or processed; all datasets are technical, anonymised, and used solely for software development, validation, and interoperability purposes.

4.1.5.6 Data Description – Task 5.6: APIs and APPs Allowing V2X User Interaction

This task involved the generation and processing of software and technical data to implement the frontend of the Open V2X Management Platform (O-V2X-MP), as described in Deliverable D5.6 [28]. The developed dashboard supports two user types, CPOs and EV drivers, and provides functionalities for authentication, charger visualization, tariff monitoring, session tracking, and route navigation. The datasets include JSON message exchanges, configuration files, encrypted authentication tokens (AES, JWT), and communication logs between the frontend and backend through REST APIs. Additional data were generated from functional testing, including simulated tariffs, capacity constraints, and user interactions. The application was implemented using Node.js and Vue.js, with supporting libraries (Leaflet, Axios, OpenWeatherMap API) and tested through the project's GitHub environment. All data are non-personal, technical, and stored in structured formats in secure repositories (PPC, INESC-ID, GitHub, SharePoint). No personal or sensitive data were collected or processed; all datasets are used exclusively for software validation, usability testing, and demonstrator integration.

5 V2X Societal Adoption Data

This section summarises the data collected under Work Package 3 (WP3), which examines the societal and systemic dimensions of V2X integration within European smart cities. The work focuses on how citizens, EV users, and energy stakeholders perceive, and accept V2X technologies, linking technical deployment with behavioural and policy insights.

The datasets include quantitative surveys and qualitative interviews, providing complementary views on user behaviour, charging preferences, awareness of flexibility services, and attitudes toward energy-sharing schemes. All data are GDPR-compliant, anonymised, and structured according to FAIR principles, ensuring accessibility and long-term reusability. Collectively, they support a holistic understanding of how technological innovation and social adoption converge to enable smart and sustainable energy systems.

5.1 Purpose of the data collection and generation

The data collected and generated within WP3 aim to understand how V2X technologies can be effectively integrated into smart-city ecosystems by linking social, technical, and policy perspectives. The primary purpose is to identify behavioural, institutional, and infrastructural factors that influence the large-scale adoption of V2X solutions across Europe. Data collection combines quantitative surveys, qualitative interviews, and complementary grid and simulation datasets to assess user perceptions, attitudes, and readiness toward bidirectional charging, flexibility services, and energy-sharing schemes. Together, these datasets enable a comprehensive analysis of how human behaviour, market design, and technological innovation interact to shape the transition toward inclusive, resilient, and user-centred V2X integration in smart cities.

5.2 DMP data collection and evaluation approach

5.2.1 Social adoption status

The social adoption status of V2X technologies within the EV4EU project reflects the growing but uneven maturity of user awareness, acceptance, and engagement across the four demonstrator countries. Findings from WP3 reveal that while public understanding of electric mobility is increasing, V2X concepts such as bidirectional charging, flexibility markets, and energy sharing remain relatively new to most users. Data collected through the Societal Context Survey and EV user studies in Portugal, Slovenia, Greece, and Denmark show positive attitudes toward electric vehicles, with participants expressing willingness to adopt smart-charging solutions when clear financial, environmental, or convenience-related benefits are demonstrated. However, the results also highlight persistent gaps in knowledge, trust, and perceived complexity, particularly regarding data privacy, interoperability, and the impact of flexibility services on personal mobility routines [32].

At the institutional level, expert interviews indicate that regulatory uncertainty, fragmented infrastructure standards, and limited cross-sector collaboration still constrain large-scale V2X deployment. Nevertheless, stakeholders, including DSOs, municipalities, and energy providers, acknowledge the strategic role of user participation in ensuring future grid resilience. Overall, the data point to a transitional phase of social adoption, where awareness and readiness are emerging but require continued engagement, education, and incentive frameworks to translate acceptance into sustained participation in V2X-enabled energy ecosystems [32].

5.2.2 Social adoption data description

A major component of WP3 includes, but is not limited to, surveys and interviews aimed at understanding public attitudes toward electric mobility and V2X technologies.

- The Societal Context Survey gathered 802 responses across five languages (English, Portuguese, Slovenian, Danish, and Greek) to evaluate perceptions of EV adoption, charging habits, public charging preferences, V2X awareness, incentives, and expectations. Conducted via Qualtrics between March and September 2025, the data are stored in password-protected Excel format and will be made publicly available once anonymised.
- EV user surveys were performed between November 2022 and February 2023 in Slovenia, Greece, Denmark, and Portugal, collecting country-specific insights into users' experiences and charging behaviours (23–52 responses per country).
- Expert interviews were conducted first, involving 16 key stakeholders, including policymakers, DSOs, aggregators, and energy providers, from Portugal, Slovenia, Greece, and Denmark. These aimed to identify systemic needs and barriers to EV and V2X adoption from both regulatory and infrastructural perspectives.
- Subsequently, surveys and in-depth interviews with EV users were carried out between 2022 and early 2023, both in person and remotely, to capture habits, barriers, and expectations regarding V2X. A total of 24 user interviews were conducted across the four countries (8 in Slovenia, 4 in Greece, 7 in Denmark, and 5 in Portugal).
- Finally, a societal context survey was implemented to assess broader public attitudes toward electric mobility and V2X technologies, complementing the qualitative insights gathered in earlier stages.

All societal datasets are owned by SEL, stored securely on project SharePoint and Notion platforms, and password protected. They will be disseminated only after analysis, ensuring privacy and compliance. Keywords associated with these datasets include EV adoption, e-mobility perceptions, charging preferences, and V2X awareness.

6 Conclusions

This deliverable presented the Data Management Plan (DMP) for the Electric Vehicles Management for Carbon Neutrality (EV4EU) project.

Aligned with Horizon Europe's Open Science policies, the DMP plays a key role in ensuring that all project data are open and Findable, Accessible, Interoperable, and Reusable (FAIR), and managed according to high ethical and technical standards.

EV4EU has established a comprehensive data management framework that guarantees secure storage, traceability, and full compliance with FAIR principles and the General Data Protection Regulation (GDPR) requirements. Using standardised formats, interoperable protocols, and harmonised metadata, datasets from all demonstrators and Work Packages (WPs) are efficiently integrated to support modelling, simulation, and social validation of Vehicle-to-Everything (V2X) strategies.

The adopted approach combines Open Science practices with rigorous privacy and cybersecurity safeguards, leveraging trusted repositories and tools such as Microsoft SharePoint, PostgreSQL, and MariaDB. This framework ensures data quality, interoperability, and transparency across partners, providing a strong foundation for future research, collaboration, and innovation in smart and sustainable electric mobility (e-mobility).

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