D2.1 Preliminary collection of operational digital platforms for energy and transport crossborders in EU

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[1] PU = Public

PP = Restricted to other programme participants (including the Commission Services)

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Document history

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Summary

Begonia Project

Europe is embarking on a transformative endeavour to modernise digital information usage, with a focus on enhancing the efficiency, sustainability, and connectivity of our energy and transportation sectors. At the core of this initiative lies the development of advanced ODPs that transcend national boundaries, leveraging state-of-the-art technologies such as data sharing, cloud computing, and network connectivity.

The BEGONIA Project is an EU-funded Coordination and Support Action that aims to expedite this digital transformation in the energy and transport sectors, analysing the most promising solutions and providing information to the European Commission to set up and fund future works project(s).

BEGONIA has the goal of identifying, studying and preparing the development of ODPs across different EU countries, starting from the identification of 10 cross-border and possibly cross-sector (energy and transport) use cases, meticulously shortlisting three based on predefined criteria, and evaluating their impacts through proof-of-concept implementation of their ODPs.

Summary of the Deliverable

As one of the first and most important steps in the Begonia project, this deliverable aims to identify use cases in energy, mobility, and cross-sector energy/mobility. These use cases will be further discussed and analysed from different perspectives such as solution architecture and governance scheme (deliverable D3.2) and shortlisted into six and finally, three use cases using cost-benefit analysis and feasibility studies (deliverables D3.3 and D3.4).

The use cases are defined and described in such a way as to cover different aspects of energy and mobility in cross-border and cross-sector manners. Different approaches are followed to obtain the use cases. Some use cases are the results of direct interviews and discussions with related stakeholders. The ongoing projects such as Omega-X and InterConnect are other sources of obtaining use cases. Additionally, partners' expertise and experiences in the energy and mobility sectors are used to define or expand the use cases.

In the deliverable, first, the concepts of use case and ODPs are defined. Then, to have a clear and uniform description of the use cases, standard IEC 62559 is introduced and used as the methodology to structure use case presentations and analysis. In the next section, use cases descriptions are presented. 14 use cases from energy and mobility sectors are selected and presented. Additioally, 5 additional use cases that are not listed as the selected use cases but could provide insights for readers are presented briefly. A preliminary SWOT analysis is perfeomed in section 4, to discuss the main strengths, weaknesses, opportunities, and threats thof use cases. Finally, the deliverable will be concluded in section 6.

Disclaimer

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Table of Acronyms

Acronyms	Description
AI	Artificial Intelligence
BRP	Balancing Responsible Party
CBA	Cost-Benefit Analysis
CEF	Connecting Europe Facility
CL	Controllable Load
CPP	Charge Point Providers
DC	Data Center
DSO	Distribution System Operator
EASA	European Union Aviation Safety Agency
EC	European Commission
EMS	Energy Management Systems
EMSP	E-Mobility Service Providers
ES	Electricity Supplier
ET	Electric Truck
EU	European Union
EV	Electric Vehicle
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
HVAC	Heating, Ventilation, and Air Conditioning
KPI	Key Performance Indicator
MPO	Metering Point Operator
ODP	Operational Digital Platform
P2P	Peer-to-Peer
PC	Project Coordinator
PV	Photovoltaics
RES	Renewable Energy Resource
SGAM	Smart Grid Architecture Model
SOC	State Of Charge
SWOT	Strengths, Weaknesses, Opportunities, and Threats

TSO	Transmission System Operator
UML	Unified Modeling Language
UPS	Uninterruptible Power Supply
V2G	Vehicle-to-grid
V2X	Vehicle-to-Everything
WP	Work Package

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1. Introduction

1.1 BEGONIA Project

The aim of the BEGONIA Project is to expedite the European digital transformation by analyzing promising solutions and providing recommendations to the European Commission (EC). Specifically, the project focuses on identifying, studying, and preparing the development of ODPs in the energy and transport sectors across various European Union (EU) countries, with the goal of facilitating the setup and funding of future projects.

1.2 Work Package 2

Work package (WP) 2 sets the foundations for WP3 and the rest of the project activities. WP2 aims to identify the most promising use cases regarding the digitalisation of energy and mobility sectors within the EU member states involved in the consortium and use cases. To this end, the WP applies a methodology to assess and select the most representative cross-border energy and mobility and cross-sector energy/mobility use cases. A necessary research and technology analysis is concluded to identify the main requirements for defining these use cases. This analysis will include data space design principles, communication infrastructure requirements, new services for users considering transparency and public-private sovereignty, decentralized infrastructure for data management, and ethical principles.

Using the defined requirements, the 14 most promising use cases are defined to address cross-border issues regarding energy and mobility and cross-sector energy/mobility. It is envisioned that these use cases address involve 7 member states. Standards IEC62559 is used to define the use cases and include the stakeholder roles and interactions in the governance schemes.

Additionally, business models will be evaluated with a cost-benefit analysis that aims to create added value to different cross-border conditions in Europe. The cost-benefit analysis will consider technical, economic, and a prtial social aspects to support the long-term.

1.3 Deliverable description

This deliverable is focused on defining the most relevant use cases for the project. As mentioned in section 1.2, these use cases are related to energy, transport, mobility, and cross-sector fields and are tried to be defined in a cross-border manner. The latter allows the use cases to be implemented in different member states and highlights the challenges and opportunities for cross-border implementation of energy and mobility solutions. The use cases are also aligned with the EU targets and visions on energy, environment, and data.

Different approaches are used to collect the use cases. Some use cases are obtained directly from stakeholders by participating in workshops or interviews. The experiences and outcomes of ongoing projects in the fields of energy and mobility such as Omega-X and InterConnect are also used to define use cases. Additionally, partners' expertise and experiences are used to get inspired, define, or expand the idea of use cases. To provide an overview of the defined use cases, a list of selected use cases together with a short description of each use case is presented in Table 1.3-1.

Table 1.3-1 Short description of use cases.

ID	Title	Short description
BEG.01	Operational digital platforms (ODP) for distribution grids	This use case proposes an ODP for monitoring, operating, planning, and flexibility services of distribution grids. Different stakeholders such as distribution system operators (DSOs), aggregators, renewable energy resources (RES), electric vehicles (EVs), controllable loads (CLs), and customers can connect to the platform and provide or receive flexibility and grid services. One of the main capabilities of the ODP is developing a tool for generating digital twins of the main grid infrastructures that facilitates achieving the ODP objectives.
BEG.02	Digitalisation of data centers for energy efficiency and waste heat reuse	Flexible coordination of multi-energy DC systems can increase the energy efficiency and thereby the revenue and sustainability of the DC operation. This use case proposes developing a digital platform for planning, monitoring, and coordination of energy storage and waste heat reuse for DCs and providing flexible services to the electricity grid. To ensure reliable control of the DC, a digital twin of the DC is generated using hardware in the loop and data-driven approaches to test the solutions before applying them to the real system.
BEG.03	Cross-border charging coordination and traffic management of electric trucks (ETs)	Many logistics and transport companies are planning to replace traditional trucks with ETs. Large-scale use of ETs with charging considerations can cause issues in finding charging points, heavy traffic on roads toward the charging stations, and reliability and stability issues for the grid. This use case proposes an ODP for charging coordination of ETs to solve these issues considering the ETs' preferences and the level of access to ETs' charging and driving destination information.
BEG.04	AI-driven price-based methods applications in cross-border EV charging strategies	The rapid increase in cross-border commuting and EV adoption presents challenges for the electrical grid, necessitating efficient cross-region EV charging solutions integrated with renewable energy sources to address intermittency issues. A proposed system leveraging machine learning predicts energy demand and production, facilitating dynamic pricing to optimize consumption and demand management. The proposed framework aims to enhance grid stability across borders, promote sustainable commuting by considering the commuters' behavior, and support the environmental objectives of reducing energy waste and carbon emissions.
BEG.05	An ODP for interaction among EV owners, charging stations, and grid	The use case develops an electronic booking service platform that guarantees the access of EV owners to charging service across EU borders by booking the charging time slot within a group of EU countries or getting a fixed-price subscription. Getting state of charge (SOC) preferences and charge schedules through the platform allows E-Mobility Service Providers (EMSP) to forecast flexibility available within a certain period and geographic area and get profit by providing grid services.
BEG.06	A cross-border recommender tool	Large-scale integration of RESs can cause stability and reliability issues for grids due to the unpredictable fluctuations in their power output. To

	and flexibility procurement mechanism for grid services	overcome this issue, first, some preventive actions can be taken to reduce the risk of the vulnerability of the grids and then when an incident occurs (power imbalance, voltage drop, etc.), demand-side flexibility can be used to mitigate the problem effectively. In this use case, an ODP is proposed to 1) reduce the vulnerability of the grids at each member state by sending recommendations to end-users, aggregators, and energy management systems, and 2) aggregate and classify the flexibility capacity of loads and aggregators at different member states to solve issues at distribution and transmission grids levels.
BEG.07	A unified way for changing the energy service provider in EU member states	The mechanics of utility subscription change in the EU member states may be quite different in the energy market structure and data-handling regulations. This use case introduces the ODP that reconciles different traditions accepted in target member states to enable automated, secure, and regulation-compliant processes for changing the energy service provider within 24 hours.
BEG.08	Cross-border virtual communities of renewable energy resources (RESs) and CL	The uncertain output power of RESs is a barrier to their participation in electricity markets. This use case proposes a platform for aggregating the RESs and involving them in a power trading mechanism (including Pool-co, peer-to-peer (P2P)) with CLs including charging stations and HVAC systems to reduce the uncertainty of RESs and benefit all involved stakeholders. The platform also gives access to EV owners to find charging stations that provide green energy and engage in green transition.
BEG.09	Mobility 3.0	Mobility 3.0 aims to be a cutting-edge platform that connects all mobility stakeholders, including vehicle manufacturers, drivers and road managers, providing real-time traffic updates to enhance road safety and efficiency. Through seamless integration with vehicles and road infrastructure, it offers drivers instant alerts on hazards, optimizes travel routes, and aids road managers in effective traffic management. With a focus on user-centric design and robust data security, Mobility 3.0 revolutionizes the driving experience while prioritizing safety and privacy.
BEG.10	Floating Car Data for dynamic insurance services	The Insurance ODP leverages V2X technology to gather real-time data from vehicles, enabling insurance companies to develop personalized, dynamic policies based on individual driving behaviors. By collaborating with vehicle manufacturers, the platform ensures seamless data integration across Europe, allowing for accurate risk assessment and fair pricing.
BEG.11	Digital permits for drone-based inspections in linear infrastructures	Digital platform to accelerate and guarantee the applications of drone-based inspections of linear infrastructures, especially in cross-border conditions.
BEG.12	Smart Ports Operations	The Smart Port Operations Use Case leverages AI cameras and drone systems to monitor and manage port activities. Integrated into the FIWARE digital platform, adopted by the Connecting Europe Facility (CEF), this system provides real-time insights into operations and accurate volumetric measurements of stockpiles. The goal is to enhance safety,

		efficiency, and sustainability in port operations, setting a new standard for digital transformation in the maritime industry.
BEG.13	Carbon footprint of ports supply chain	Logistics operators need to make decisions for the transport of maritime goods with the lowest possible environmental impact and in a way that allows the consumer to precisely know the carbon footprint of the products they buy. This use case targets a blockchain-based platform to track and update the carbon footprint from the manufacturer to the customer in transit through different ports.
BEG.14	Inland Waterways Multimodality 4.0	Inland Waterways Multimodality 4.0 proposes a platform to connect inland waterway mobility stakeholders with other transport modes. This includes transport operators, infrastructure managers across transport modes and port authorities and other logistics hubs operators. The objective is to provide real-time logistics and goods traffic updates to improve transport efficiency and foster the shift to greener transport modes such as railways and inland waterways.

In addition to above-mentioned use case, 5 more use cases which are not selected as final use cases but can provide interesting view on energy and mobility sectors challenges and issues will be briefly described.

Standard IEC62559 is used to provide a clear and detailed description of the selected use cases.

In the next sections, first, the concepts of the use case and ODP are defined, and the methodologies used for obtaiing and describing the use cases are explained. In section 3, the high-level description of selected use cases and a brief description of additional use cases are presented. A preliminary SWOT (strengths, weaknesses, opportunities, and threats) analysis of the use cases is presented in section 4, and finally, in section 5, the deliverable is concluded.

2. Use Case Methodology

2.1 From Use Cases to ODPs

As defined by ISO/IEC 19505-2:2012, a use case is the specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system. Use cases are similar to user stories but utilize more formal language when defining the boundaries of the system and its development process.

In the case of ODPs that combine physical and virtual information communication technology resources operating in multiple domains, zones, and interoperability layers, the development process must establish a communication infrastructure that supports the flow, storage, processing, and analysis of transport and/or energy data among these resources. Natural boundaries for these operations are provided by the existing practice that includes user (in this case, business and developer) stories and EU regulations. Within this context, the use cases serve as building blocks for real-world implementation. An illustrative example of this process is given by the smart grid architecture model (SGAM) standard in Figure 2.1-1, which clearly describes the platform development process that reflects the necessities of both cross-border and cross-sector ODPs. This analogy can be more complete if the entities within the geographical scope are considered instead of or additionally to the Zones dimension.

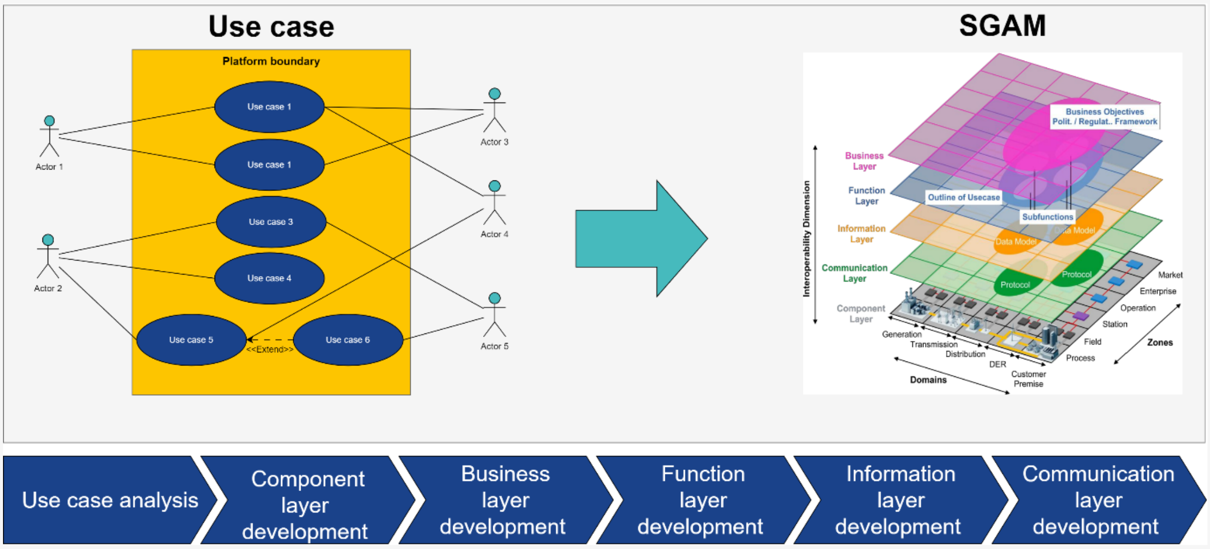

Figure 2.1-1. ODP development example [1] .

Following this approach, the ODP development starts by defining the use cases based on the existing practice and EU regulations followed by the development of the component layer. The restriction of the use case objectives to what is possible with the existing infrastructure defines their projections, first, on the Business Layer and, consequently, on the Function, Development, and Communication Layers. At each step of the development process, the use case boundaries and used standards may be updated to better serve the overall goal or specific cross-border and cross-sector interests to provide continuous guidance and reference for ODP readiness. Due to the importance of use cases in the ODP implementation process, various regulations have been defined encompassing both general and domain-specific concepts, in the first place, those that define the use case methodology and the use case templates.

2.2 Use case template

The use case methodology as a software engineering tool that supports a common understanding of functionalities, actors, and processes across different technical committees/organizations is defined in IEC 62559 (Figure 2.2-1 [2]) published by IEC Technical Committee 8 on System aspects of electrical energy supply. In compliance with the standard, the template established within standards is used here both for energy, mobility, and other usage areas. For complex systems, the use case methodology supports a common understanding of functionalities, actors, and processes across different technical committees or even different organizations. The shorter version of the use case repository template is prepared in correspondence with the IEC 62559-2 and used to describe the use cases.

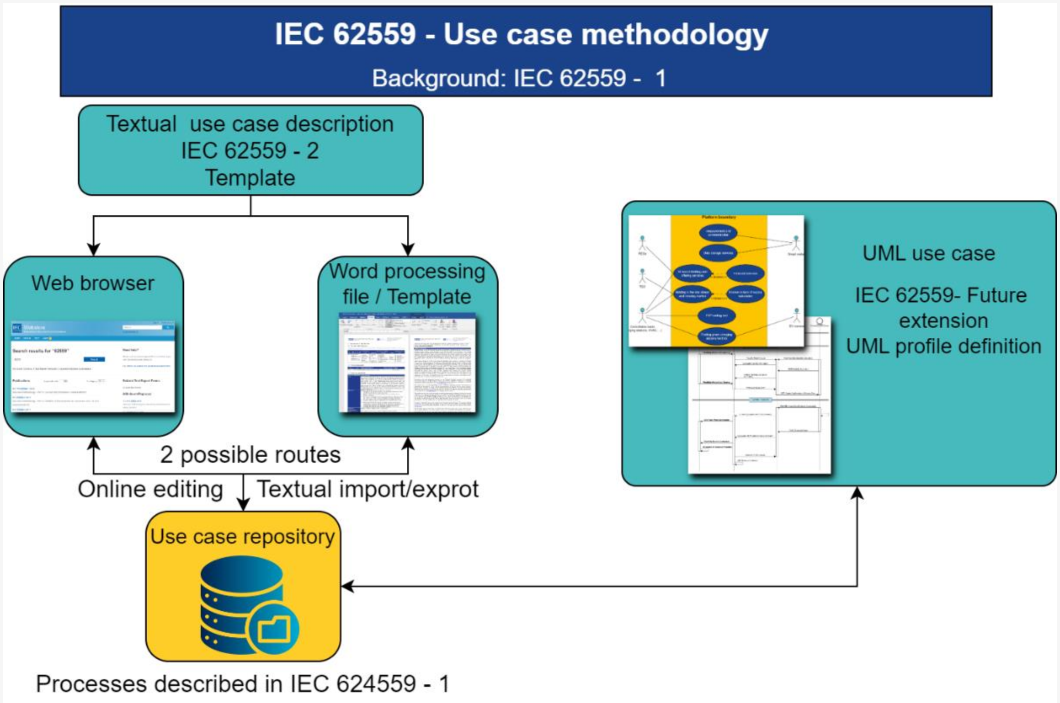

Figure 2.2-1. Use case standard IEC 62559 [2].

It includes the following sections [3]:

- **Use case identification**
  This section presents general information about the defined use case such as:
  - **Use case ID:** It is unique within the project constructed from its first letters (BEG), dot and the number of the use case, and serves for organization/administration of the use cases.

  - **Name of Use Case:** It is a short name, which should be unique within the area/domain and which refers to the activity of the use case.
  - **Geographical scope:** It is the region that the use case would impact, starting from local up to cross-border and outermost
  - **Cross-sector domains:** It is divided into three main sub-domains, including Electric, Mobility, and Data, and each sub-domain covers different aspects,
  - **Interoperability layers:** It determines different interoperability layers that the use case can cover
- **The scope and objectives of the use case**

  This section includes the following information:
  - **Scope:** The scope describes the aims and boundaries of the use case in a short, precise text.
  - **Objective(s):** The objectives are itemized in the form of bullet points and a small headline.
  - **Reference country(ies):** the countries that practice and regulatory aspects influenced the formulation of the use case.
  - **Related business case(s):** Provides a description or reference with some rationale for the suggested use case. Usually, a business case is related to several use cases.
  - **Possible stakeholders:** gives a better understanding of the concrete implication of the proposed case.
- **Narrative of the use case**

  This section provides a complete narrative of the use case from a user's point of view, describing what occurs when, why, with what expectation, and under what conditions. This narrative should be written in plain text so that non-domain experts can understand it. The length of the complete description can range from a few sentences to a few pages, depending on the complexity and/or newness of the use case. This description often helps the domain expert to reflect on the requirements for the use case. This description often helps experts to reflect on the requirements for the use case before getting into the details in the next sections of the use case template.
- **Diagram of the use case**

  The use case diagram is a Unified Modeling Language (UML) diagram that illustrates functionalities and interactions in the system. Use case diagram can help in early-stage design, as well as identifying and organizing system requirements and communicating them to the stakeholders. The elements of the developed use case diagrams include:
  - **Actors:** Represent users or other systems that interact with the system (listed in the subsequent section). Actors are typically depicted as stick figures in the diagram.
  - **Use Cases:** Represent specific functionalities or processes that the system can perform. These are usually described by oval shapes and are named with a verb-noun phrase that describes the action.

  - **System Boundary:** Sometimes referred to as a "system box," this rectangle contains all the use cases, representing the scope of the system.
  - **Associations:** Lines that connect actors to the use cases they interact with, indicating that an actor participates in a use case.
- **Actors of the use case**
  This section describes the use case actors defined in the use case diagram. The following information for each actor is provided:
  - **Actor name** that is the same as the defined name in the use case diagram,
  - **Actor type** that can be either Role or System.
  - **Actor description** that provides a brief definition of the actor. The list of relevant actor definitions originating from the EU regulations is given in Appendix A.
  - **Actions** that describe the actor's interactions in the use case
  - **IEC Standards** that are used for the actor
- **Scenarios:**
  This section focuses on describing scenarios of the use case with a step-step analysis (sequence description). There should be a clear correlation between the narrative and these scenarios and steps. In the current simplified template, only the normal sequence (success) is presented and no alternative scenarios are considered. Each scenario is defined as follows:
  - **Scenario number (S. No):** The scenarios are sequentially numbered. The number of scenarios is not limited.
  - **Scenario Name:** is used to name the scenario.
  - **Triggering Event:** describes which event(s) trigger(s) this scenario.
  - **Scenario Description:** is used to describe shortly the scenario.
  - **Primary Actor:** describes which actor(s) trigger(s) this scenario.
- **Policy and digitalisation needs**
  This section identifies the policy and digitalization needs for the successful implementation of the ODP proposed by the use case. Policy needs refer to the new rules and regulations and digitalization needs refer to required technical and technological improvements to implement the use case.

2.3 Collection of use cases: exploratory stage

In order to collect the use cases, a plan consisting of the following steps has been designed and carried out:

1) **Desk research**: European projects (especially CEF), sectoral associations, scientific and official publications, technology centres and universities involved in cross-border conditions have been consulted.
2) **Selection of the most appropriate use cases** on the basis of their cross-border, cross-sectoral and digital impact, considering the key aspects of ODPs (Figure 2.3-1).

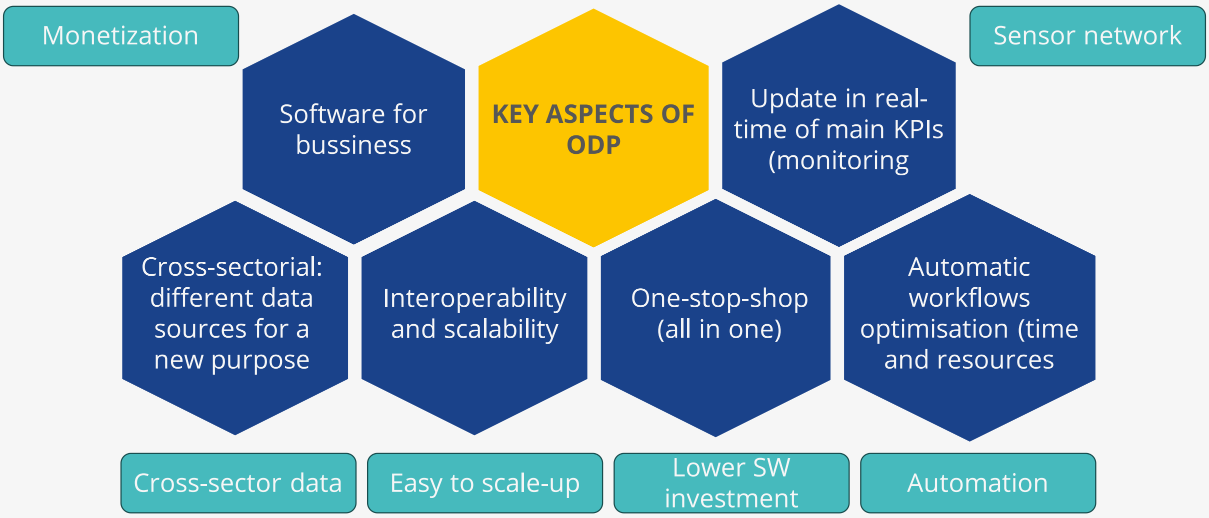

Figure 2.3-1 ODPs: key aspects (Reference source: Actindo, August 2023 - Shruti Sivakumar [4])

1) **Design of the stakeholders list**: the most important and representative actors in the research area of the energy, transport, mobility and digitalisation sectors.
2) **Setting of the communication strategy**: to get an effective communication with stakeholders and in collaboration with WP5, the structure of the information, keywords, message, minimally useful details, interview or questionnaire format, expected feedback, among others, were defined.
3) **Stakeholders interviews and long-term engagement**: companies (DSO, TSO, BRP, traffic control, mobility providers, sector associations, technology centres, public authorities (regional and national level), CEF corridors, ports, coordinators of EU projects, among others have been interviewed and invited to participate in future workshops to support the use case evaluation and implementation.
4) **Description of use cases and preliminary SWOT**: Description of use cases based on the feedback gathered from interviews and desk research with a clear focus on the implementation of pilots, which have been developed in isolation and are potentially replicable on a cross-border basis or demonstrate sufficient maturity to be implemented on a large scale.

3. Proposed use cases for energy and mobility sectors

3.1 Use case 1: ODPs for distribution grids

3.1.1 Use case identification

Table 3.1-1. Identification of the use case 1.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.01	ODPs for distribution grids	☐ Local ☒ Regional ☒ National ☐Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☒ Vehicle ☐ Energy station ☐ Infrastructure ☐ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.1.2 The scope and objectives of the use case

Table 3.1-2. Scope and objectives of the use case 1.

Scope and Objectives of the Use Case	
Scope	This use case proposes an ODP for distribution grid operation. Every DSO, RES, aggregator, EV charging point, different types of CLs such as heating, ventilation, and air conditioning (HVAC) systems, and even electricity customers can connect to the platform and receive or deliver services. The platform is equipped with a digital twin service that can receive required data from DSOs and generate digital twins of the grid and standard types of assets such as transformers. DSOs can use this service for grid services such as monitoring, forecasting, operation, and planning services. On the other hand, all the abovementioned stakeholders can have access to the platform, connect to their related DSO just by entering their basic information such as address or region, and provide flexibility services. The ODP also allows interaction with end-users via mobile applications for increasing awareness about grid status and contributing to solving grid issues in real time manually.
Objective	The main goals of the use case are as follows: • Developing a cross-border ODP for the operation and planning of distribution grids, • Increase distribution grid observability, • Developing a tool for generating digital twins of the distribution grids and transformers for any DSO that joins the platform, • Benefiting from aggregators, RESs, EVs, HVAC systems, and different types of CLs for providing grid services, • Increasing end-user awareness and engagement in distribution grid management and solving grid issues.
Reference country(ies)	Denmark
Related Business Case	Distribution grid monitor, operation, and planning, grid flexibility services.
Possible stakeholders	DSOs, Aggregators, EV charging points, Facilities with CLs, Electricity customers

3.1.3 Narrative of the use case

Power systems are facing rapid changes. Today, there is a growing investment in RESs and various sectors such as transportation and heating have an increasing tendency for electrification. Installing new capacities of PVs and wind turbines increases the uncertainty in predicting the loading of the lines and the possibility of bidirectional power flow in the girds that are not designed for it. Activating more and more EVs and using heat pumps for heating not only increases the volume of electricity consumption but also puts the system under other stresse such as harmonics and voltage regulation issues. Since most of these changes are happening at the distribution grid level, it is critical to increase the observability of distribution grids, optimally operate the grid, and find the best investment solutions for grid reinforcement [5].

On the other hand, demand-side flexibility as a grid service is becoming more and more popular. DSOs need a tool to facilitate interaction with different stakeholders that can participate in the flexibility procurement programs.

In this use case, an ODP is proposed to help the DSOs solve grid issues and provide the possibility of interaction between the DSOs and different stakeholders. Since it is important to test any solution in the grid before implementation, the platform should have a tool for generating digital twins of the grids and the main assets such as transformers. This will allow the DSOs to simulate any operational, planning, and flexibility solutions accurately before implementing them in the real system. Data-driven and AI-based methods should be developed in the ODP that receive grid data operate the digital twins. The digital twin tool should be designed in a generic way that can be applied to any distribution grid only by receiving grid and power consumption data. This is an essential point for guaranteeing the scalability of the ODP.

The main requirements of the proposed ODP are presented in Figure 3.1-1. The ODP should provide two types of services: 1) grid services, and 2) flexibility services. Some examples of the main grid services are as below:

- **System Monitoring:** Monitoring the grid using the data received from the smart meters,
- **Estimation:** Developed digital twins can be used to estimate grid parameters in nodes that are not equipped with smart meters,
- **Transformers aging control:** Oil temperature is one of the key parameters that affect the lifetime of the transformers. Transformers digital twin can be used to predict the oil temperature and make the best real-time decisions to manage the temperature in the next time intervals,
- **Transformers dynamic rating:** The static rating of the transformers is calculated in standard temperatures. However, in many cases, the temperature is much less or more than the standard temperature. So, static rating can be replaced by

dynamic rating. This requires developing methods for calculating dynamic ratings using load and temperature forecasts,

- **Phase balancing:** Phase unbalances increase power losses in the grid. In addition to the direct costs of losses, they can play a key role in increasing the hot-spot temperature of transformers and reducing their lifetime. The digital twin model can be used to find optimal solutions for mitigating this issue,
- **Grid planning:** Using the grid digital twin, the impacts of different planning strategies for grid reinforcement (installing new lines, transformers, power capacitors, and other equipment) could be evaluated before implementation. The models also provide the possibility of testing solutions at different forecasted scenarios for the behavior of consumers in the future to increase the robustness of solutions.

Figure 3.1-1. Requirements of the proposed ODP for use case 1.

Using the ODP for the abovementioned services can decrease the monitoring, operation, maintenance, and investment costs of the DSO. The main flexibility services can be as follows:

- **Flexibility aggregation:** The ODP should be capable of aggregating and classifying the flexibility capacities received from flexibility providers, i.e., aggregators, RESs, EVs, or other loads,

- **Flexibility needs calculation:** Using the grid digital twins, the minimum flexibility that is needed to solve grid issues should be calculated,
- **Flexibility procurement:** The ODP should have a mechanism for procuring the required flexibility, e.g., a market mechanism,
- **Assessment:** A method is needed to assess if the promised flexibility by every flexibility provider in the ODP is procured successfully or not,
- **Settlement:** Procured flexibilities should be financially settled by flexibility providers. Advanced methods should be used to calculate the price for flexibility services that encourage the end-users to participate in the program and support the economical considerations of the DSO,
- **End-user awareness and engagement:** The ODP can give limited access to end-users through a mobile application to observe grid status at an understandable level for the public and react manually and voluntarily. This increases the awareness of the end-users of grid issues and engages them in flexibility provision process without causing additional costs.

Any flexibility provider or end-user should be able to connect to its related DSO by inserting minimum information such as address or region, and several DSOs in one member state or different member states can use the platform at the same time. Additionally, all the processes of providing services should be done automatically. End-users who receive flexibility requests via the mobile application and react manually and voluntarily do not need to meet these requirements.

3.1.4 Diagram of the use case

Figure 3.1-2 represents the diagram of the use case 1. The descriptions of actors and scenarios are presented in Table 3.1-3. and Table 3.1-4., respectively.

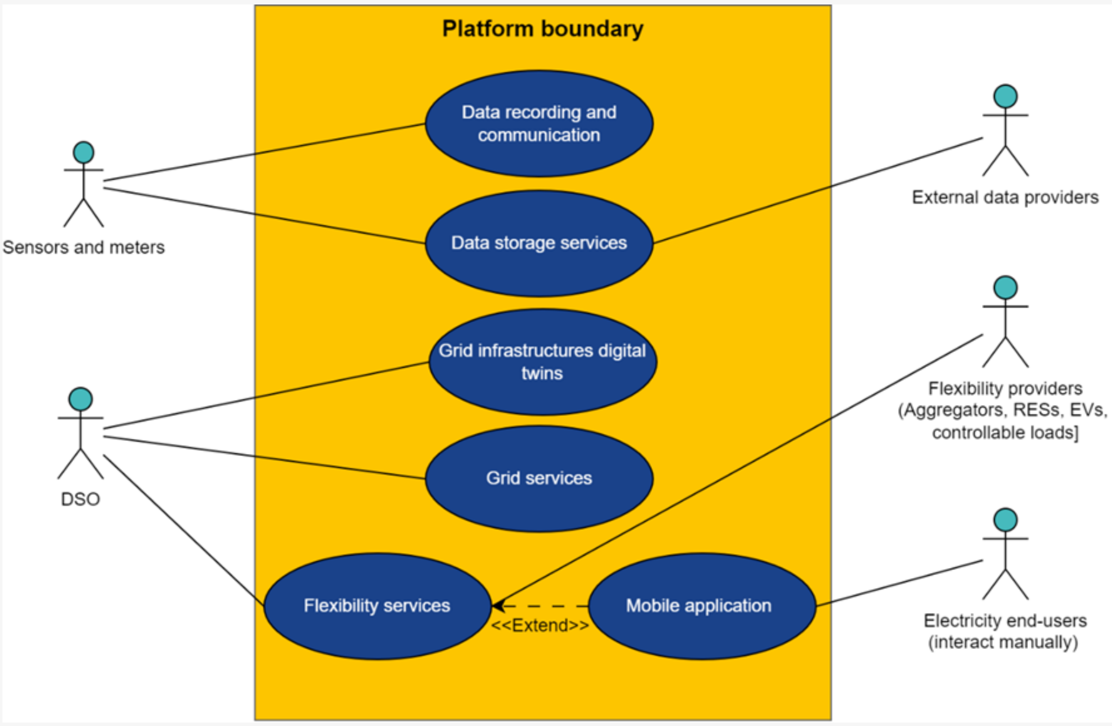

Figure 3.1-2. Diagram of the use case 1.

3.1.5 Actors of the use case

Table 3.1-3. Description of the actions of use case 1 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	DSO determines the required services for the ODP and uses the ODP to exploit different grid and flexibility services and ensure efficient operation and planning of the distribution grid.	No
Sensors and meters	System	Sensors are electronic components that respond to physical or chemical stimuli, that is, they detect variations in the environment in which they are inserted. A meter is a system that makes it possible to take measurements of parameters. It is assumed that both sensors and meters are capable of transferring data to the data storage, otherwise, communication devices should be added to them	Sensors measure parameters such as temperature in transformer boxes, while meters record electrical measurements like voltage and current. These devices transfer data to the data storage system. If they lack communication capabilities, they should be equipped with appropriate communication devices.	No
Flexibility providers	Role	Any devices in the grid which the output power or consumed power can be controlled. They can include individual devices or aggregators that manage a group of controllable devices.	Flexibility providers interact with ODP to provide flexibility services. Their interaction must be autonomous using the smart management systems at CL terminals to respond to grid requirements.	No
Electricity end-users	Role	Consumers of electricity	End-users provide flexibility service manually by adjusting their electricity consumption after receiving a notification in the mobile app.	No
External data providers	Role	Data providers are research institutes, industry associations, and sometimes different consultancy companies which are paid by different companies to supply data to eco-invent.	They receive weather, price, etc information, provide forecasts, and send them to the data storage. This data can be used by service providers or digital twin developers.	No

3.1.6 Scenarios

Table 3.1-4. Description of use case 1 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.01.S1	Data recording and communication	Continuous, A new measurement received	Different electrical parameters such as voltage, current, power, and other parameters such as temperature are measured by smart meters and sensors from different locations in the grid and sent to the data storage	Sensors and meters
BEG.01.S2	Data storage services	New data is received	All the data received from smart meters and data providers should be stored in the data centers and can be used by digital twin developers and service providers.	Sensors and meters and external data providers.
BEG.01.S3	Grid infrastructures digital twin	Continuous	Digital twin developers use the data in data centers and the grid data received from DSOs, apply AI-based approaches, and develop digital twins for gird and transformers. They can ask for more metering points and sensors to achieve efficient models.	DSO
BEG.01.S4	Grid services	When the DSO recognizes the need for a grid service	DSO uses the tools in the ODP and the digital twin to simulate any grid solution before implementation using the grid services	DSO
BEG.01.S5	Flexibility services	When the DSO recognizes the need for a flexibility service	DSO uses the tools in the ODP and the digital twin to calculate the required flexibility, procure it from stakeholders, and settle the transactions.	DSO
BEG.01.S5	Mobile application	During the ODP development	The mobile app allows customers to connect the ODP. Receive notifications and provide services manually and voluntarily.	

3.1.7 Policy and digitalisation needs

Table 3.1-5. Description of use case 1 policy and digitalisation needs.

Policy needs	• As end-users are one of the core elements in developing the grid's digital twins, end-users should be ensured that the privacy of their data is preserved. Policies should be in place to guarantee that user data is securely stored and only used for its intended purposes. • In case the platform is used by different states, the policies for storing data in different member states should be considered.
Digitalisation needs	• Interoperability between different elements of the platform.

3.2 Use case 2: Digitalisation of energy storage and reuse in Data Centers

3.2.1 Use case identification

Table 3.2-1. Identification of use case 2.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.02	Digitalisation of energy storage and reuse in data centers	☐ Local ☐ Regional ☒ National ☐Cross-border ☐ Outermost	☒ Customer ☐DER ☐Distribution ☐ Transmission ☐ Generation	☐ Customer information ☐Vehicle ☒ Energy station ☐ Infrastructure ☐ Traffic and logistic	☐ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.2.2 The scope and objectives of the use case

Table 3.2-2. Scope and objectives of use case 2.

Scope and Objectives of the Use Case	
Scope	DCs require a significant amount of electricity to cool down the servers and almost all of this energy is wasted as heat. As solutions to increase the energy efficiency of DCs, it is suggested to equip them with cold-storage units, RESs, power storage units, and waste heat reuse technologies. Adding all these technologies increases the flexibility capacity of DCs and enables them to provide ancillary services for the grids and reduce their operation costs. However, several services should be developed to make the most optimal decisions on the size of the above-mentioned technologies and their operation. This use case proposes an ODP that provides all required services for monitoring and managing DCs to reduce their expenses and make their business more sustainable through flexible coordination of RESs, energy storage, waste heat reuse, and provision of ancillary services.
Objective	Objectives of digitalisation of energy storage and reuse in DCs: • Developing an ODP for monitoring, operation, and planning of DCs, • Developing operational services for cost-effective operation of DCs considering different combinations of technologies such as heat, cool, and electricity storage technologies, and RESs, • Developing planning services for decision-making on using different technologies for reducing costs and increasing efficiency, • Developing services for providing ancillary services for the power system.
Reference country(ies)	Denmark
Related Business Case	Data center operation, energy management, energy trading, carbon neutrality, Auxiliary service,
Possible stakeholders	Data centers, TSO.

3.2.3 Narrative of the use case

DCs are growing rapidly across Europe. According to a recent report by Data Economy, the European DC market is expected to grow by a compound annual growth rate of 11.4% between 2021 and 2026 [6]. Furthermore, according to a report by the EC's Joint Research Centre, DCs consume around 3% of the total electricity consumption in the EU [7]. However, in some individual cities or regions, DCs can consume much higher shares of the total electricity, particularly if the area has a high concentration of DCs providing large flexible capacity to transmission system operators (TSOs). As this share is expected to grow, DCs will contribute to the energy transition toward the carbon-zero energy system. Hence, it is necessary to make the DC industry a more proactive contributor to sustainable energy systems.

Figure 3.2-1 shows the data center, its related technologies, and possible opportunities for investment to improve energy efficiency and reduce operational costs. In conventional structures, cooling devices consume electricity to cool down the data center servers, there is an auxiliary energy resource such as an uninterruptible power supply (UPS) as a backup in the cases of power grid failure, and the heat generated by servers is dispersed into the environment (walls, air, ground, etc.) and lost forever. New designs suggest equipping the DCs with new electrical and thermal technologies. On the electrical side, it is suggested to add batteries, RESs, and EV charging points to the system to increase flexibility in operation. On the thermal side, it is suggested to have a cool storage and waste heat reuse system.

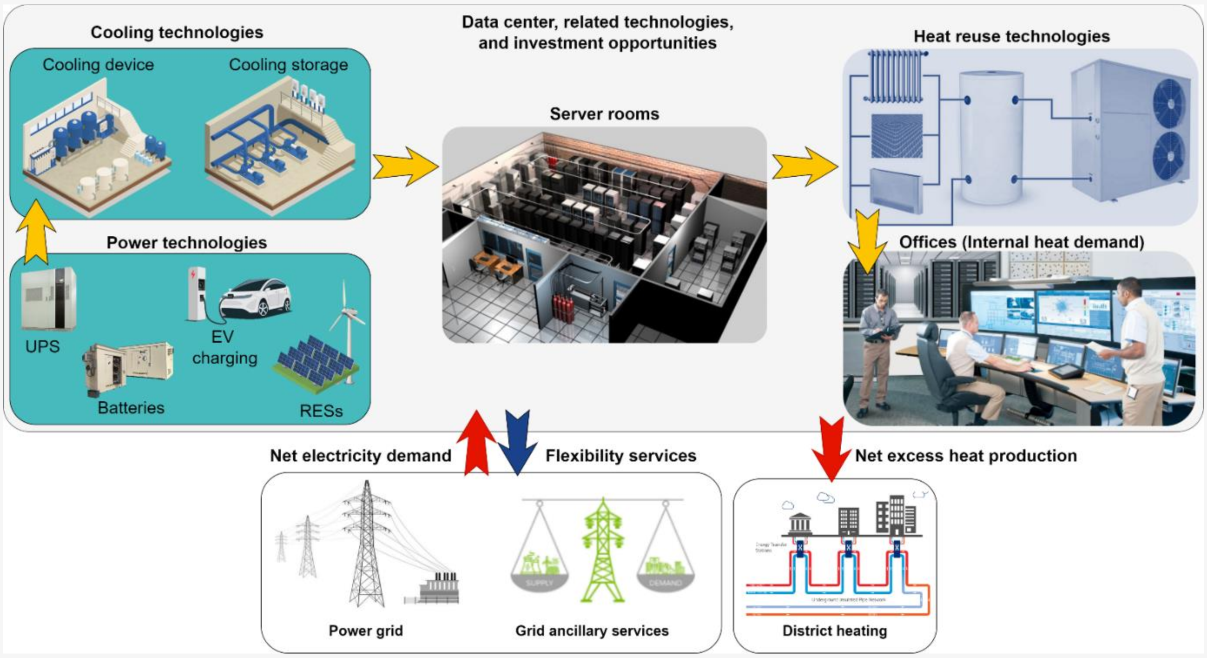

Figure 3.2-1. Data center, related technologies, and investment opportunities.

The storage of "cold" happens when the cold-water storage tank is charged during lower chiller cost periods and discharged during higher chiller cost periods. Similarly, waste heat reuse utilizes heat storage and more efficient heating technologies such as heat pumps to benefit from the heat produced by the DC to supply the heat demand of the DC offices and the external demand for heat in district heating. The flexibility provided in the operation of the DC by all these technologies enables the DC to participate in the ancillary service market and provide services such as balancing and voltage regulations for TSO or DSO.

It is worth noting that the reliable operation of DCs is a critical task. A failed test with a new design can lead to overheating and damage to servers as well as costly downtimes. Therefore, safe off-site hardware tests are necessary before integrating new technologies and accompanying controllers in the DC control system. To this end, a digital twin of the DC and related technologies should be developed using advanced AI algorithms to test any planning or operational solution before applying it to the real system.

This use case proposes developing an ODP for flexible coordination and testing of different technologies for DCs. This ODP should have a tool for developing digital twins of the DCs and evaluating different technologies that can be used to improve efficiency and reduce costs. It should be generic enough to be applied to different DCs and technologies. This ODP is expected to provide the following services:

- **Monitoring service:** The data received from different sensors and smart meters can be visualized and presented to the DC operators,
- **Planning service:** This service provides testing capabilities within ODP on a technology or a group of technologies that the DC manager would like to integrate into the existing system. To this end, the developed digital twin is tested with new technologies, and the results are evaluated from technical and economic perspectives,
- **Operation service**: Receives the real-time data, forecasted parameters, and status of different devices (UPS, EV charger, RES, cool storage, etc) and schedules the operation of devices considering technical and reliability constraints,
- **Grid flexibility service:** Advanced methods and the latest measurements are used to forecast the flexibility of the DC system and offer it to the TSO or DSO taking into account the rules and regulations,
- **Emergency response and recovery:** Since the reliable operation of DCs is a very important task, an emergency response and recovery strategy should be defined to ensure the reliability of the DC's operation.

Regarding flexibility services, an agreement between DCs and TSO/DSO is needed to define the way the DCs can contribute to providing grid services.

The novelty of this use case consists in creating a platform capable of demonstrating how DC would operate under the integration of new energy technologies, in the first place, under an optimized and coordinated heat reuse schedule without actual deployment inside the DC.

3.2.4 Diagram of the use case

The diagram of use case 2 is presented in Figure 3.2-2. Use case actors and scenarios are explained in Table 3.2-3. and Table 3.2-4., respectively.

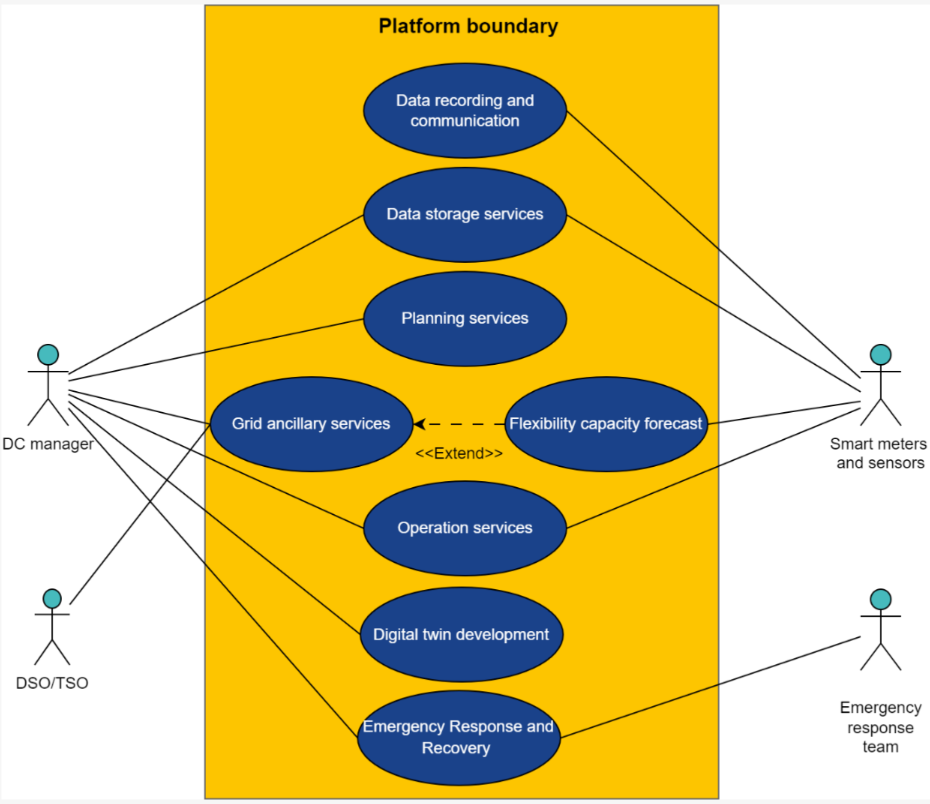

Figure 3.2-2. Diagram of use case 2.

3.2.5 Actors of the use case

Table 3.2-3. Description of the actions of use case 2 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Smart meters and sensors	System	Sensors are electronic components that respond to physical or chemical stimuli, that is, they detect variations in the environment in which they are inserted. A smart meter is a digital device that measures and records energy consumption in real-time.	Sensors measure parameters such as temperature in transformer boxes, while meters record electrical measurements like voltage and current. These devices transfer data to the data storage system. If they lack communication capabilities, they should be equipped with appropriate communication devices.	No
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	DSO determines the required services for the ODP and uses the ODP to exploit different grid and flexibility services.	No

TSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	Defines the requirements and rules for the data center to provide ancillary services.	No
DC manager	Role	Supervise the overall smooth and successful operation of the operational scenarios.	Perform tests on different parts of the digital platform, ensure reliable commutation between the DSO/TSO, meters, and the data center, and ensure that the data center system provides ancillary services within the agreed terms.	No
Emergency response team	Role	A group of people who prepare for and respond to any emergency incident.	They detect system failures, security breaches, or other emergency incidents and react to support the reliability of the DC.	No

3.2.6 Scenarios

Table 3.2-4. Description of use case 2 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.02.S1	Data recording and communication	The measurement time interval has elapsed, measurement request is sent by the DC manager/ODP.	The data monitoring service receives the data from different sensors and smart meters, visualizes them, and presents them to the DC managers and TSO. The data is processed in real-time to detect anomalies and generate alerts if thresholds are exceeded. This ensures continuous monitoring and quick response to any issues.	Sensors and smart meter
BEG.02.S2	Data storage services	New data is received	All the data received from smart meters and sensors is stored in the data centers and can be used by digital twin developers and service providers.	Sensors and meters and external data providers.
BEG.02.S3	Planning services	A new device is to be integrated into the DC, new control logic is required or a new	DC manager configures and runs the planning service using digital twin based simulation and forecasting tools to decide which technologies, their	DC manager

		regulation is applied in the DC.	configuration, and operation strategy would best serve the purpose of DC renovation/upgrade with objectives of reducing costs and increasing efficiency of the integrated solution.	
BEG.02.S4	Digital twin development	Based on the results of planning and operational tests, the DC manager decides on the final configuration of the integrated device/control/constraint system.	The data center manager works with the team of engineers to describe a recent design for control logic/device/constraint and integrate it into a digital twin for the updated system. This digital twin is used to simulate the operational behavior of the data center under various conditions to ensure reliability and efficiency before actual implementation.	DC manager
BEG.02.S5	Operation services	Continuous, in specific time intervals.	The operation service receives the real-time data, forecasted parameters, and status of different devices and schedules the operation of devices considering technical and reliability constraints applied to the existing and newly integrated equipment. The developed digital twin is tested with new technologies, and the results are evaluated from technical and economic perspectives. This ensures that the integration of new equipment and control strategies is optimal and reliable before full-scale deployment.	DC manager
BEG.02.S6	Flexibility capacity forecast	Continuous, in specific time intervals.	Taking into account the DC needs and status of the devices, a methodology is used to forecast the flexibility capacity of the DC for providing grid services.	
BEG.02.S7	Grid ancillary services	A grid service required by DSO or TSO	The ODP/DC manager offers the flexibility capacity to the TSO or DSO taking into account the rules and regulations, and provides flexibility when needed.	DC manager
BEG.02.S8	Emergency Response and Recovery	Detection of a system failure, security breach, or other emergency.	The emergency response service activates protocols to mitigate damage, secure data, and restore normal operations. The digital twin helps simulate emergency scenarios and plan recovery strategies.	DC manager, Emergency response team

3.2.7 Policy and digitalisation needs

Table 3.2-5. Description of use case 2 policy and digitalisation needs.

Policy needs	• Regulations are needed to facilitate the participation of data centers in the grid services, • Digital platfrom should support regulations established in different countries for DC-TSO interaction,

Digitalisation needs	The technical barriers in this use case come from the necessity to adopt the developed ODP to the properties of a specific infrastructure for cooling, heating, and electrical subsystems that the specific DC exploits: • Design details of storage and production technologies would impose different construction and operation constraints on the cooling system, • Type of DC cooling and heating systems. One has to test all solutions for the correct infrastructure and therefore detailed data is required about the DC to make the digital twin. This leads to the need for an accurate and reconfigurable digital twin that would adapt its behavior based on the change in the DC topology. The interoperability barriers that have to be overcome are: • Identification of standard construction principles for the digital twin to make the solution transferable, • The interoperability layers of the digital twin design must reflect those for the actual DCs under investigation (communication protocols, data handling, functions), • The Scada systems for DCs are not normally constructed in an interoperable way, e.g. transformers between the Scada and ODP communication protocols may be necessary.

3.3 Use case 3: Cross-border charging coordination and traffic management of ETs

3.3.1 Use case identification

Table 3.3-1. Identification of use case 3.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.03	Cross-border charging coordination and traffic management of ETs	☐ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☐ Transmission ☐ Generation	☒ Customer information ☒ Vehicle ☒ Energy station ☒ Infrastructure ☐ Traffic and logistic	☒ Edge ☐ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.3.2 The scope and objectives of the use case

Table 3.3-2. Scope and objectives of use case 2.

Scope and Objectives of the Use Case	
Scope	This use case proposes an ODP for charging coordination and route planning of ETs. The aim is to provide optimal charging service, reduce traffic issues, and mitigate the grid issues caused by charging a large number of ETs. The main property of the ETs that makes them different from private EVs is the predetermined destinations which makes the coordination and scheduling for charging more precise and reliable. Different companies can connect the platform, allow different levels of access to their ETs' charging data, charging points, and driving destinations, and receive the best route planning and charging services. The platform can also analyze the need for grid investments

	in areas with a large number of ET charging points to ensure quality of service for ETs and grid reliability.
Objective	The main objectives of the use case are as follows: • Proposing an ODP for facilitating the charging coordination of ETs considering distribution grid limitations, • Managing traffic and reducing waiting time for charging ETs in charging stations, • Fair sharing of charging capability among different companies taking into account the number of ETs and minimum charging requirements of ETs, truck routes, and available cross-border charging stations, • Providing adaptive charging strategies for companies based on the level of access provided to data, • Developing tools for evaluating different planning solutions for increasing the charging capability of the areas with high penetration of ET charging stations and finding the most optimal solutions, • Utilizing the flexibility of aggregated charging stations for providing ancillary services for power systems.
Reference country(ies)	Denmark, Germany, Sweden, Norway, and Finland
Related Business Case	ETs' charging coordination, Traffic management, grid services
Possible stakeholders	Logistics companies, ET owners, TSO, DSO, Charging stations

3.3.3 Narrative of the use case

Transportation is the fastest-growing source of emissions worldwide and now accounts for 14 percent of GHG emissions [8]. In this regard, achieving the long-term transition to a low-carbon European economy requires special attention to the electrification of the transport sector. Among different types of transportation systems, medium and heavy trucks are the sources of 22% of GHG emissions [9]. The transition toward truck electrification has already started and logistics and transport companies are planning to replace traditional trucks with ETs. While there are currently more than 4,000 ETs on the road, this number will reach 600,000 ETs in 2030, comprising 50% of new registered trucks [10]. ETs have characteristics that make them different from private EVs. The size of the battery of the ETs is much bigger than EVs and more importantly, the daily destination of the ETs is usually known which makes it possible to easier calculate the required energy and plan for charging.

Large-scale integration of ETs raises several challenges. The necessity to charge the ETs may lead to heavy traffic on the roads close to charging stations and long waiting times in queues to connect to the charging point. Additionally, since these ETs normally belong to companies, and in some cases, several companies in industrial parks may start using ETs, soon, we will be faced with areas in the distribution grids with very high penetration of ETs charging stations. An example of these areas is in Børup in Denmark which is a main transit route from Germany to Denmark, Sweden, Norway, and Finland. This area is in the intersection of two motorways and many companies such as PostNord, Blue Water Shipping, DHL, Arla Foods Taulov, DANX, and Danske Fragmænd have terminals in this area. It is estimated that these companies own more than 7000 trucks excluding the passing trucks. Some of these companies like PostNord have already started installing charging stations and planning to upgrade their fleet by 2026 to ETs. This area in Denmark is already a growing concern for the local DSOs which struggle with grid expansion, and for the Danish TSO to increase the capacity in that region using renewables. In this case, the transport sector is causing additional stress on the energy sector, which may lead to stability issues and power cuts.

To overcome these issues, in this use case, an ODP is proposed that can provide charging coordination and route scheduling services for ETs, propose investment solutions for increasing the charging capacity of the charging stations, and estimate aggregated flexibility in charging stations and offer it to the DSO or TSO as a flexibility service. The main requirements of the ODP users and the specifications of the ODP are illustrated in Figure 3.3-1.

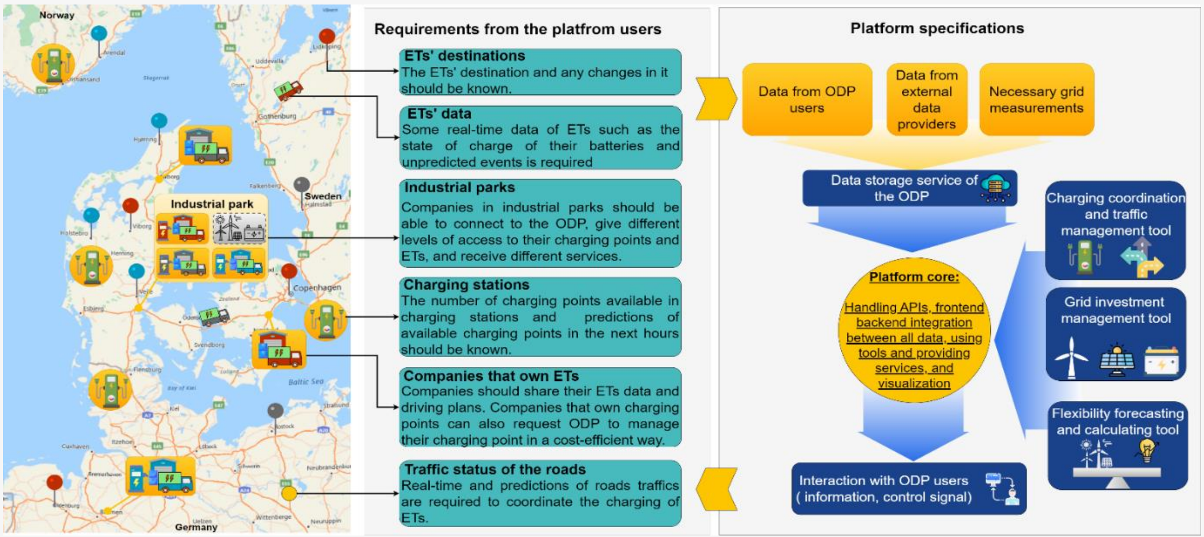

Figure 3.3-1. Illustration of the requirements from platform users and the specifications of the platform.

The platform should include private ETs or groups of ETs that belong to companies. The information regarding the destination of ETs, and the characteristics of the ETs such as their location, battery size, and SOC of the batteries should be reported to the ODP. The platform should also be capable of including both private charging stations and charging stations that belong to ET-owner companies and provide charging coordination based on the level of access to the information that is determined by the charging station owners. The platform should also provide charging coordination services for industrial parks with several companies. The companies can give access to the detailed charging requirements of each one of their ETs or the aggregated required energy for a period and receive a charging schedule for each ET or assigned hourly energy consumption capacity for a period, respectively. The assignment of the energy for charging ETs of different companies should be done considering grid limitations and minimum charging requirements of each ET, different options for ETs on the way to their destinations, the road traffic, and the timetable for delivering the goods. To use the charging points on the route, the platform should also allow the ETs to book charging stations in advance to reduce the waiting time in queues. Since the number of charging stations is limited, the charging point assignment to ETs can cause road traffic. The platform should perform the charging coordination and route planning for ETs such that the impact on road traffic is minimized. The ET owners should also be able to interact with ODP using mobile apps or any other tools to report sudden changes in the driving route or events such as accidents to reschedule the programs.

As another tool for the ODP, the ODP can also receive information about charging stations and ETs in the industrial parks with several companies and grid limitations and analyze different solutions for increasing the charging capacity of the charging stations or industrial parks to cover the maximum number of ETs. These solutions can be a) grid reinforcement programs, b) installing new renewable distributed generation resources e.g., PV panels and wind turbines, c) energy storage systems, and d) installing non-RESs such as combined heat and power (CHP) units. Furthermore, access to a large number of charging stations, information about ETs connected or scheduled to be connected to charging points, and other information about ETs allows the ODP to calculate the aggregated energy flexibility in the platform and offer it to DSO or TSO as a flexibility service.

3.3.4 Diagram of the use case

The diagram of the use case 3 is presented in Figure 3.3-2. Actors' actions and scenarios' descriptions are presented in Table 3.6-3. and Table 3.6-4., respectively.

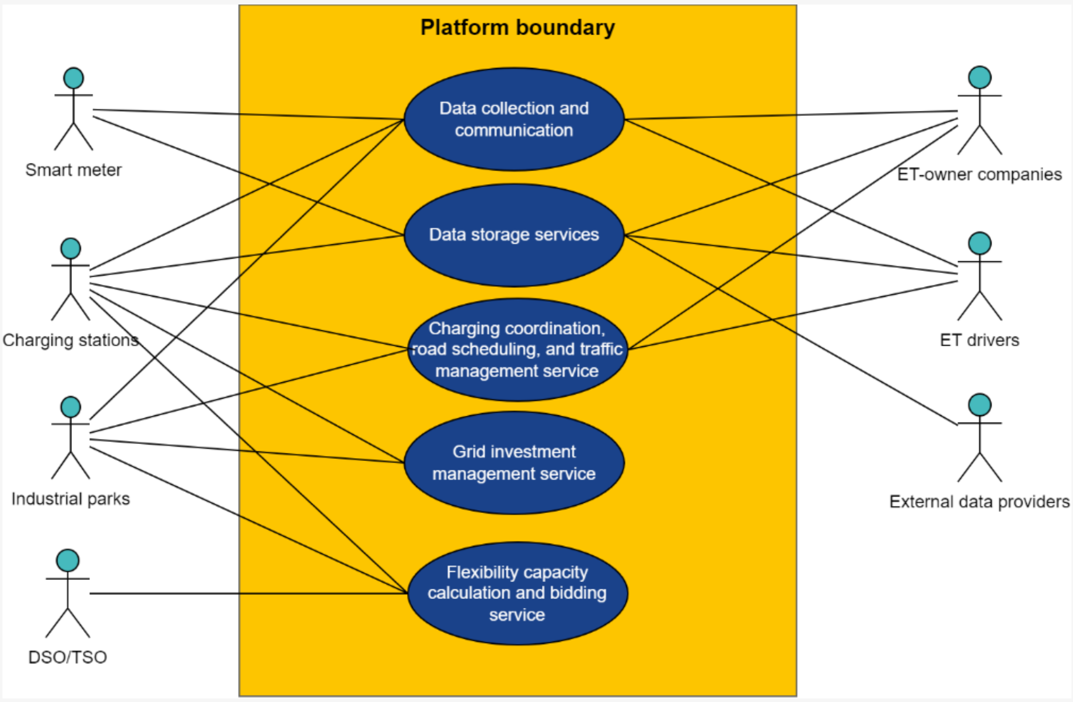

Figure 3.3-2. Diagram of the use case 3.

3.3.5 Actors of the use case

Table 3.3-3. Description of the actions of use case 3 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Smart meters (volt, current, power factor, watt, and power quality meters)	System	A smart meter is a digital device that measures and records energy consumption in real-time.	Smart meters collect the data from the grid, charging stations, and ETs and communicate it with the data storage.	No
Charging stations	Role	A charging station (CS) is physical equipment consisting of one or more charging station controllers and one or more electric vehicle supply equipments managing the energy transfer to and from EVs.	Communicate the data on the availability of charging points with the ODP and receive control signals for chargers or booking a charging point for an ET. Charging stations can also request for analyzing the investment solutions for increasing charging capacity	No
ET owner companies	Role	Logistics companies that own ETs are responsible for managing their fleet's charging needs and schedules.	Communicate the data of their ETs, their destinations, and timetables, and the data of charging points (if available) with ODP. Perform the calculations needed by ODP such as minimum energy needed for a period. Agree on the level of access to the data and coordination of the charging points with ODP. Receiving control signals from the ODP	No
ET drivers	Role	Drivers of the ETs are responsible for operating the vehicles and reporting real-time conditions.	ET drivers can send information about sudden events such as accidents to the ODP. The ODP helps the ETs to book a charging point and receive route-scheduling services.	No
Industrial parks	Role	An area of land developed as a site for factories and other industrial businesses; an industrial estate.	In addition to the charging coordination and route scheduling services, industrial parks can receive power investment solutions for increasing the charging capacity of the area and reducing the stability issues of the grid.	No
DSO/TSO	Role	DSO is responsible for ensuring the maintenance of and, if necessary, developing the distribution system in	ODP can participate in the balancing market and provide balancing services for TSO.	No

		a given area, where applicable, and ensuring the long-term ability of the system to meet electricity demands. TSO is responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet electricity demands.	Additionally, if DSO is willing to use flexibility solutions, it can use the flexibility offered by ODP to solve distribution grid issues.	
External data providers	Role	Data providers are research institutes, industry associations, and sometimes different consultancy companies which are paid by different companies to supply data	Required data for ODP services such as electricity price is received from external data providers.	No

3.3.6 Scenarios

Table 3.3-4. Description of use case 3 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.03.S1	Data collection and communication	Continuous	The parameters of the charging stations, ETs, industrial parks, and distribution grid are measured and sent to the data storage.	Smart meters, ET-owner companies, charging stations, ET drivers, industrial parks
BEG.03.S2	Data storage services	New data is received	All the static and dynamic data sent from ODP users are saved and processed in the data storage.	Smart meters, ET-owner companies, charging stations, ET drivers, industrial parks
BEG.03.S3	Charging coordination, road scheduling, and traffic management service	Any update on the status of ETs and charging stations	Based on the most recent information, the ETs charging coordination is performed taking into account the ETs' preferences, road traffic status, and distribution grid limitations.	ET-owner companies, charging stations, ET drivers, industrial parks
BEG.03.S4	Grid investment management service	Request received from industrial parks or charging stations	The ODP analyzes the required energy of the area using historical data, considers different properties of the area such as geographical conditions and the investors' preferences, and determines the type and size of the technologies that can be used to increase the charging capacity.	Charging stations, industrial parks
BEG.03.S5	Flexibility capacity calculation and bidding service	Continuous in specific time intervals	Considering the regulations of flexibility procurement and the data received from charging points and users, the available flexibility of the system is calculated and offered to the existing ancillary service markets.	Charging stations (private or charging points of companies)

3.3.7 Policy and digitalisation needs

Table 3.3-5. Description of use case 3 policy and digitalisation needs.

Policy needs	The main policy concerns for this use case are about data sharing. • Regulations are required to allow data sharing among member states. • Regulations are needed to facilitate the participation of ODP and charging stations in providing grid services, • There are concerns about if the companies are willing to share their internal data such as their required charging energy, the charging status of their ETs, and the daily route of their ETs.
Digitalisation needs	• The platform should have access to real-time and historical data on the grid, companies, charging stations, • The companies should have tools for estimating the required energy for ETs for the next day, • The platform should be able to apply its decisions to charging stations with different technologies.

3.4 Use case 4: AI-driven price-based methods applications in cross-border EV charging strategies

3.4.1 Use case identification

Table 3.4-1. Identification of the use case 4.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.04	AI-driven price-based methods applications in cross-border EV charging strategies	☐ Local ☒ Regional ☐ National ☒ Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☐ Transmission ☒ Generation	☒ Customer information ☒ Vehicle ☒ Energy station ☒ Infrastructure ☒ Traffic and logistic	☐ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.4.2 The scope and objectives of the use case

Table 3.4-2. Scope and objectives of use case 4.

Scope and Objectives of the Use Case	
Scope	This use case is designed to address the complexities of scaling up EV charging infrastructure across national borders, with a focus on infrastructure scalability, mitigating the grid impact, refining cost and pricing strategies, and leveraging RESs. As EV adoption surges, the demand for a robust, cross-border charging network becomes crucial, posing challenges for the existing electrical grids, especially during peak charging periods. This initiative aims to develop a smart, sustainable, and scalable EV charging solution that not only facilitates seamless cross-border mobility for EV users but also incorporates smart charging technology and renewable energy to alleviate the strain on electrical grids supported by state-of-the-art artificial intelligence (AI) solutions. Additionally, the project intends to develop standard user profiles by analyzing patterns in historical user behavior data. By implementing dynamic pricing models based

	on the amount of renewable energy produced and the standard charging profiles, the project intends to make cross-border EV charging accessible and economical, thus fostering greater EV uptake. Emphasizing renewable energy integration ensures that the expanded charging network supports the transition to a low-carbon transport sector, aligning with global sustainability goals.
Objective	The main objectives of the use case are as follows: • Develop a smart, sustainable, and scalable EV charging infrastructure that enhances mobility for EV users, using smart charging technology and renewable energy to reduce the strain on electrical grids, • Propose a digital platform that facilitates the coordination of EV supply equipment (EVSE), • Develop weather-based AI methods to predict future production levels of renewable energy systems, • Implement dynamic pricing models based on the availability of renewable energy to make EV charging more affordable and promote greater adoption of EV leading to better utilization of surplus renewable energy, • Integrate renewable energy sources into the EV charging infrastructure to reduce the carbon footprint and support the transition to a low-carbon transport sector, • Crafting adaptive charging frameworks that adjust to real-time grid conditions and renewable energy availability, optimizing charging schedules based on data-driven insights, • Analyze historical user behavior data to create standard user profiles, improving the efficiency and user experience of the EV charging process, • Support the expansion of the EV charging network with a focus on renewable energy integration, facilitating a shift towards a more sustainable and low-carbon transportation sector in alignment with global sustainability objectives.
Reference country(ies)	Austria, Hungary
Related Business Case	EV charging, renewable energy trading
Possible stakeholders	EV charging points, RESs, EV owners

3.4.3 Narrative of the use case

A significant percentage of people living in border settlements frequently commute between countries. In 2020 more than 700.000 Austrian workers commuted abroad [11]. This cross-border commuting necessitates a cross-region, bilateral infrastructure to support the daily routines of commuters in terms of transportation. In recent years the adoption of EVs in commuting has gained a large momentum. In 2023 50.000 new EVs were sold in Austria [12], which shows an exponential growth during the years. This poses several challenges including the increased demand put on the electrical grid. Ensuring reliable and efficient access to charging stations to support commuters using EVs is essential in terms of economics, health, and environmental goals.

Establishing cross-border EV charging solutions would facilitate a more sustainable model for commuting by fostering closer cooperation between neighboring countries. Integrating renewable energy sources into the EV charging systems can reduce the carbon footprint and promote the use of green energy, making a significant contribution to the fight against climate change. Providing reliable charging options even for cross-border commuters can encourage them to transition from fossil fuel vehicles. However, besides these advantages, there are also unique challenges that need to be addressed.

One of the most pressing problems is the intermittency of renewable sources such as wind turbines and photovoltaics (PVs). Solar and wind energy are the primary renewables used in charging infrastructure. They are relatively cheap and efficient, but they highly fluctuate based on weather conditions and time of day. This intermittency can lead to periods where the available renewable energy does not align with the charging demand from commuters, particularly during peak times or unfavorable weather conditions, potentially straining the grid or necessitating reliance on non-renewable backup sources. If cases of surplus energy production aren't handled optimally it can lead to significant wasted energy. One way to address this issue is to build advanced energy storage systems to store excess renewable energy when production exceeds demand and release it during periods of high demand or low renewable generation. However, maintaining, scaling, and building these energy storage systems can be very costly and difficult, especially in cross-country cases. They also might have a significant environmental impact. The proposed use case provides a distributed solution that facilitates better and more efficient utilization of renewable energy while providing solutions to the difficulties mentioned above. A generic framework for the proposed use case is illustrated in Figure 3.4-1 The framework of the proposed platform.

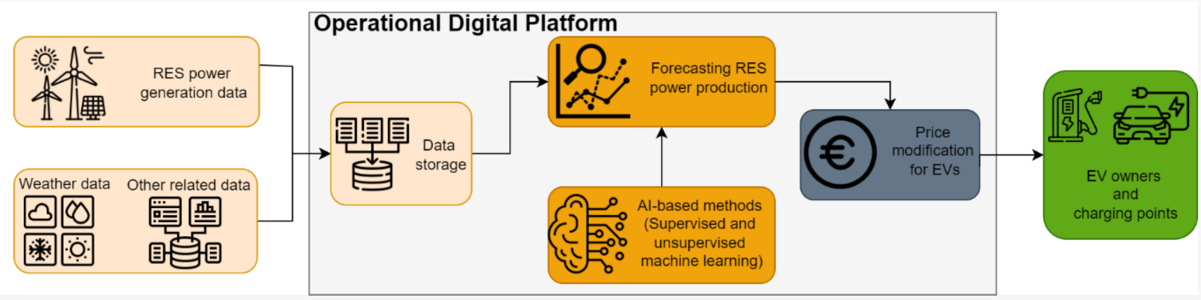

Figure 3.4-1 The framework of the proposed platform

The proposed system observes the factors affecting the production (like weather) and consumption (like peak hours of commuter traffic) of energy. The use case implements state-of-the-art supervised and unsupervised machine learning algorithms to predict the effects of these factors. Using these predictions, EV supply equipment providers can speculate on the price of the energy based on the amount produced.

The companies can use this information to offer dynamic pricing encouraging optimal consumption by customers from both sides of the border. This solution can alleviate the stress put on the grid, thus increasing the user experience of using EVs. It also leads to a lower amount of wasted energy which reduces the carbon footprint of the collaborating countries.

By leveraging predictive analytics, the system can not only forecast energy production from renewables but also anticipate the demand for EV charging.

The proposed system represents a multi-stage cross-border ODP that

- **Analyzes the charging behaviors of commuters** gaining actionable insights from the processed data. This is done by cutting-edge machine learning-based profiling algorithms,
- **Provides relevant and effective recommendations to optimize the charging behavior** according to the commuters' travel patterns along domestic and long-distance routes while ensuring consistency of service for EV owners in different member states,
- **Helps to ensure the balancing of supply and demand across different jurisdictions** minimizing the impact of renewable energy's intermittency on a larger scale. This includes calculating EV charging schedules that ensure efficient utilization of surplus RES production,
- **Enables communication between different actors** using advanced communication technologies and the Internet of Things (IoT). These technologies facilitate the real-time exchange of data between EVs, charging stations, renewable energy producers, and grid operators located within the EU,
- **Includes the impact of the specific mobility and energy transfer conditions** across different EU borders, e. g. available transfer capacity, through historical and real-time data analysis.

By harnessing the power of machine learning for predictive analytics, encouraging dynamic pricing to manage demand, and improving communication and collaboration across borders, this solution not only mitigates the intermittency of renewable energy but also promotes the adoption of EVs, contributes to grid stability, and advances the transition towards a more sustainable and interconnected energy future. The machine learning models can also identify and forecast anomalies (shortages, overgeneration) in the energy generation processes, these should be shared with the providers, so they can react on time. The effect of these anomalies could be mitigated by proposing different charging points for the users or by adjusting the pricing to it.

3.4.4 Diagram of the use case

The diagram of the use case 4 is presented in Figure 3.4-2. The description of actors and scenarios descriptions are provided in Tables 3.4-3 and 3.4-4.

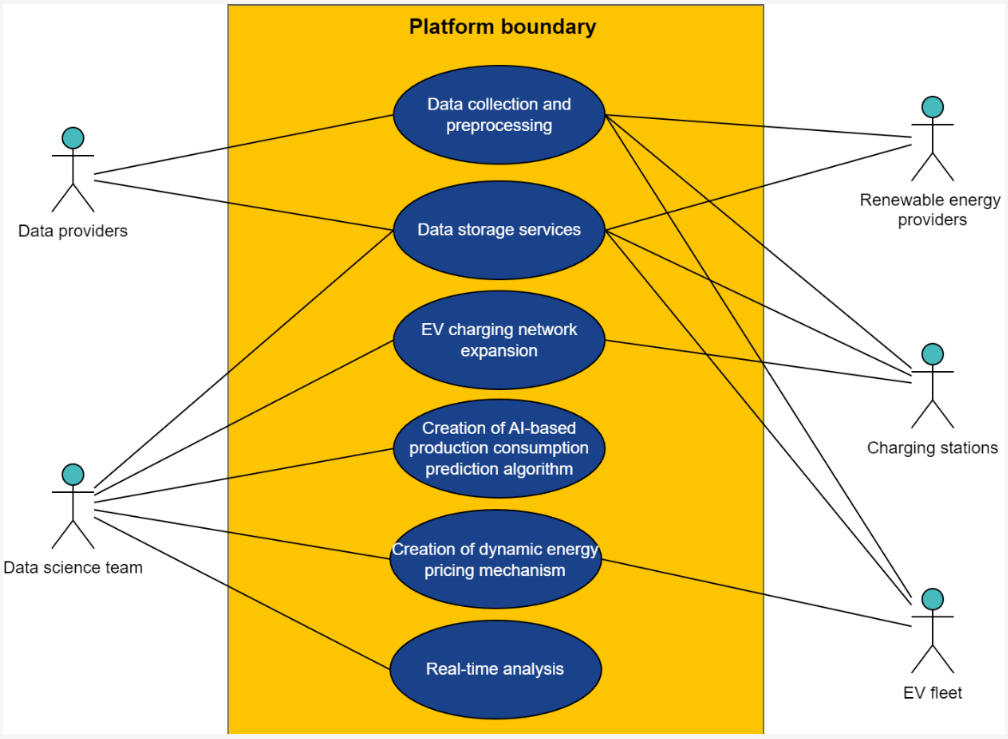

Figure 3.4-2. Diagram of the use case 4.

3.4.5 Actors of the use case

Table 3.4-3. Description of the actions of use case 4 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Data providers	Role	Data providers are research institutes, industry associations, and sometimes different consultancy companies which are paid by different companies to supply data to eco-invent.	Collect and supply the necessary additional information such as weather and price to the ODP, in compliance with the data science team's needs. This data is used by other ODP services in conducting testing and validation of data-driven models and price modeling.	No
Charging stations	System	Physical equipment consisting of one or more charging station controllers and one or more electric vehicle supply equipments managing the energy transfer to and from EVs.	Communicate in real-time with an ODP to monitor usage and performance, supplying data to real-time analysis and data processing services. Charging stations also receive dynamic prices from the ODP.	No
Data Science Team	Role	Group of data scientists analyzing, implementing, testing, and deploying data-driven solutions.	Define requirements for data collection, develop, validate, and test in real-time the AI-based forecasting algorithms and pricing mechanisms.	No
EV Fleets owners	Role	Businesses, governments, or organizations that own and operate groups of EVs	Collaborate with other stakeholders to test the ODP in specific member states and cross-border conditions	No

		for various purposes, including delivery, transportation services, and employee commuting.	ensuring the robustness of the developed algorithms and price calculators. Send location data to the ODP and receive price options in different charging stations of member states at different hours.	
Renewable Energy Providers	Role	Companies or organizations that generate electricity from sustainable sources such as wind, solar, hydroelectric, and biomass, offer cleaner alternatives to fossil fuels.	Providing information about renewable energy production.	No

3.4.6 Scenarios

Table 3.4-4. Description of use case 4 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.04.S1	Data collection and preprocessing	Continuous, when new data is generated by RESs, charging stations EVs and data providers	Data is recorded by smart meters and sensors in the RESs and charging station locations or by data providers	RESs, charging stations and data providers
BEG.04.S2	Data storage service	Continuous, by receiving data from RESs, charging stations, EVs and data providers	The data received from RESs, charging stations, EVs and data providers are preprocessed and stored to be used by the data science team.	Data science team.
BEG.04.S3	AI-based energy production and consumption prediction	The algorithms are updated continuously	Implementing and validating machine learning to forecast the production and consumption of renewable energy. By using these predictions, EV supply equipment providers can speculate on the price of the energy based on the amount produced and expected consumption.	Data Science Team
BEG.04.S4	Dynamic energy pricing	Continuous, when power production and consumption forecast is updated	Development of a dynamic energy pricing scheme to balance the supply and demand across different jurisdictions, minimizing the impact of renewable energy's intermittency on a larger scale.	Data Science Team

BEG.04.S5	Real-time analysis	Continuous	The Data Science Team continuously monitors the power balance condition in member states and the performance of the pricing and prediction algorithms to improve them	Data Science Team
BEG.04.S6	EV charging network expansion	When optimal placement for a new charging station is needed	Considering the historical data, optimal locations for installing new charging stations are obtained and informed to investors.	Data Science Team

3.4.7 Policy and digitalisation needs

Table 3.4-5. Description of use case 4 policy and digitalisation needs.

Policy needs	The main policy concerns for this use case concern data sharing and EV-specific regulations, in particular, • Data-sharing agreements must be made with renewable energy producers, EVSE, and mobility fleet owners or traffic operators, considering general data protection regulation (GDPR) both domestically and between member states. It should be stated from the beginning that personal data will not be acquired, stored, and processed, only aggregated energy consumption, generation, and mobility data, • There are concerns about whether the companies are willing to share their internal data such as energy produced, the energy consumption from EVSEs, and the daily route of their EVs. The quality and quantity of the acquired energy generation, consumption, and mobility datasets can alter the accuracy of predictive analytics models, • Imbalances brought on by RESs must be balanced in the balancing market. New regulations are required to allow EVs to be directly involved in mitigating these imbalances, • Support from local regulations is needed to apply price adjustments. Different energy market conditions may preclude RES-generation-based tariffs, • Building and maintaining the necessary infrastructure for cross-border EV charging, including charging stations, energy storage systems, and communication networks, requires significant investment. We could foster the efficient deployment of the infrastructural elements, by providing detailed insights and analysis about the user consumption and mobility patterns for the providers.
Digitalisation needs	The platform needs • Access to real-time and historical data of the renewable energy suppliers, EVSE and mobility fleet owners, • Communications channels to EV users (like the fleet's or traffic management's mobile apps), • Identify and agree on requirements for data quantity and quality with the data provider to be able to test and benchmark the AI algorithms.

3.5 Use case 5: An ODP for interaction among EV owners, charging stations, and grid

3.5.1 Use case identification

Table 3.5-1. Identification of use case 5.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.05	An ODP for interaction among EV owners, charging stations, and grid	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☒ Transmission ☐ Generation	☒ Customer information ☒ Vehicle ☒ Energy station ☒ Infrastructure ☒ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.5.2 The scope and objectives of the use case

Table 3.5-2. Scope and objectives of use case 5.

Scope and Objectives of the Use Case	
Scope	Charge Point Providers/Operators (CPPs) play a crucial role in the EV ecosystem by designing and managing the infrastructure for EV charging. Being primarily restricted to specific geographical locations, they enable monitoring and real time control of charging stations. EMSPs, on the other hand, focus on giving users access to a broader network of charging stations often managed by several CPPs, as well as providing related business services including predictive analytics, integrated energy management and enhanced grid services. They can have a stronger profile for flexible operations and deeper knowledge of regulatory compliance in different countries. The collaboration of EMSPs and CPPs for the cross-border coordination of charging and grid operations across the EU requires advanced digital tools for data storage, analysis and GDPR, as well as communication and business transactions. By combining these tools, the use case aims at building an ODP enabling high-quality booking and charging services for EV owners and real-time flexibility monitoring services for EMSPs. As a secondary objective, it would enable more profitable participation in the ancillary service market by the EMSPs.
Objective	The main goals of the use case are as follows: • Provide on-demand charging services to EV owners traveling between the member states, alleviating waiting times and improving logistics, • Providing optimal charging point selection, booking and managing services considering the location and trip plan, • Developing an EV roaming service and facilitating the cross-border payments, • Developing methods to use EVs flexibility for ancillary services to solve grid challenges at distribution and transmission levels.
Reference country(ies)	France, Belgium

Related Business Case	Grid operation, EV charging service, E-roaming
Possible stakeholders	DSOs, Aggregators, EV charging points, Facilities with CLs, Electricity customers

3.5.3 Narrative of the use case

The number of EVs on the roads is growing exponentially. EVs became the third most popular choice among buyers in 2023, with a 14.6% share [13]. The European Automobile Manufacturers' Association (ACEA) reported that the overall volume of EV sales in the EU in 2023 surpassed 1.5 million units, reflecting a substantial 37% increase compared to 2022 [14]. This impacts different systems and stakeholders, creating both difficulties and potential benefits. With the increase in EVs comes a greater need for more charging points, making it crucial for EV owners to find available and affordable charging stations. However, simultaneous charging of many EVs can cause grid congestion. To address this, coordination methods at charging stations can be used to manage the load, reduce grid impacts, and even provide services for the DSO or TSO.

In this use case, a cross-border ODP is proposed to manage the interactions among EV owners, CPPs, and grid at the EU level offering:

- Booking services to EV owners that can choose charging locations based on their preferred route within the EU, plan their route based on the cheapest charging, or subscribe to roaming service with fixed charging prices within the EU,
- Real-time operation services to EMSP who gets better grasp on the future charging operations,
- Benefit to CPPs due to increased utilization of charging points.

A possible solution to the above operation requirements is by creating an ODP interface for EMSP to influence the charging speed of the booked location by agreement with local CPPs. The flexibility for more effective operation is unlocked through coordinated charging power regulation in all locations. The coordination schedule is calculated in real-time based on charging cost minimization under the SOC constraints fixed by the EV booking service in well-defined time periods.

To demonstrate the concept, Figure 3.5-1 shows different transactions communicated at different times between the ODP services and physical actors (EVs, DSO/TSOs, and CPPs) connected through their UIs/APIs:

- An EV owner registers/authenticates with the ODP thereby identifying the type of user subscription. i.e. real-time dynamic price or E-roaming. In the first case, the dynamic local price at the charging point is used to calculate the charging cost. Using E-roaming, EV owners can buy subscriptions that guarantee a fixed predetermined price up to certain levels of charging anywhere for the subscribed consumers,
- An EV owner books the time slot on a charging network within a group of EU countries by sending the information about the vehicle, payment method, and

final SOC to the ODP. Alternatively, the user can define a route for the whole trip and get an estimation of the best price,

- The total estimated cost is automatically calculated and sent back to the consumer,
- When the end of charging is reported by CPP, the payment is transferred, and an electronic invoice is sent back to the consumer,
- If the regulations impose bidding flexibility in a day-ahead manner, a flexibility estimator tool calculates the available flexibility for the next day using AI and other advanced methods,
- A tool is required for procuring the flexibility for ancillary services in real time,
- A geographical data analysis tool will also be useful for managing flexibility in a location-based manner for providing grid services that require flexibility in certain locations.

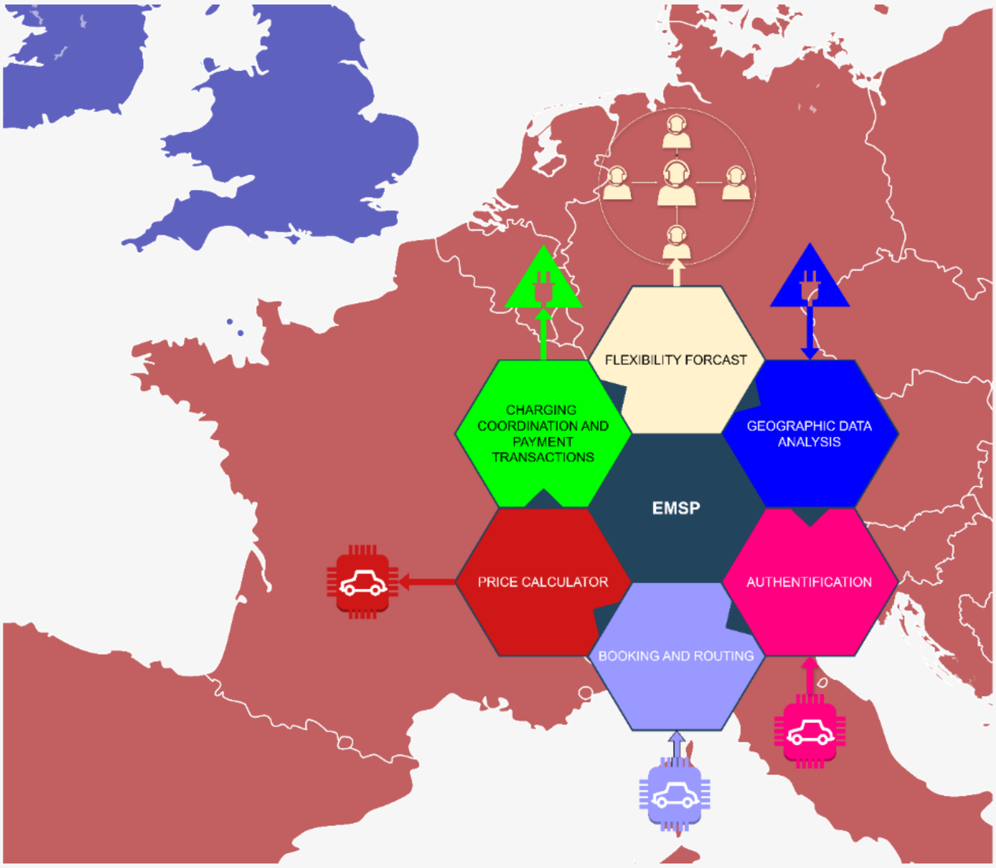

Figure 3.5-1. Time-snapshot of ODP transactions proposed by use case 5.

Depending on the country of service, different payment methods may be supported, but standard payment methods (VISA, MasterCard, bank transfer) are supported irrespective of the location of charging stations.

Successful implementation of the method requires some technical information about charging stations and connected EVs to the charging stations such as charging rates and Vehicle-to-grid (V2G) capability of the Vs.

In the case of providing grid services, the ODP will have revenue just like other ancillary service providers that can be included in the EV owners' bill as a discount.

3.5.4 Diagram of the use case

The diagram of the use case 4 is presented in Figure 3.5-2. Actors' actions and scenarios' descriptions are presented in Table 3.5-3. and Table 3.5-4., respectively.

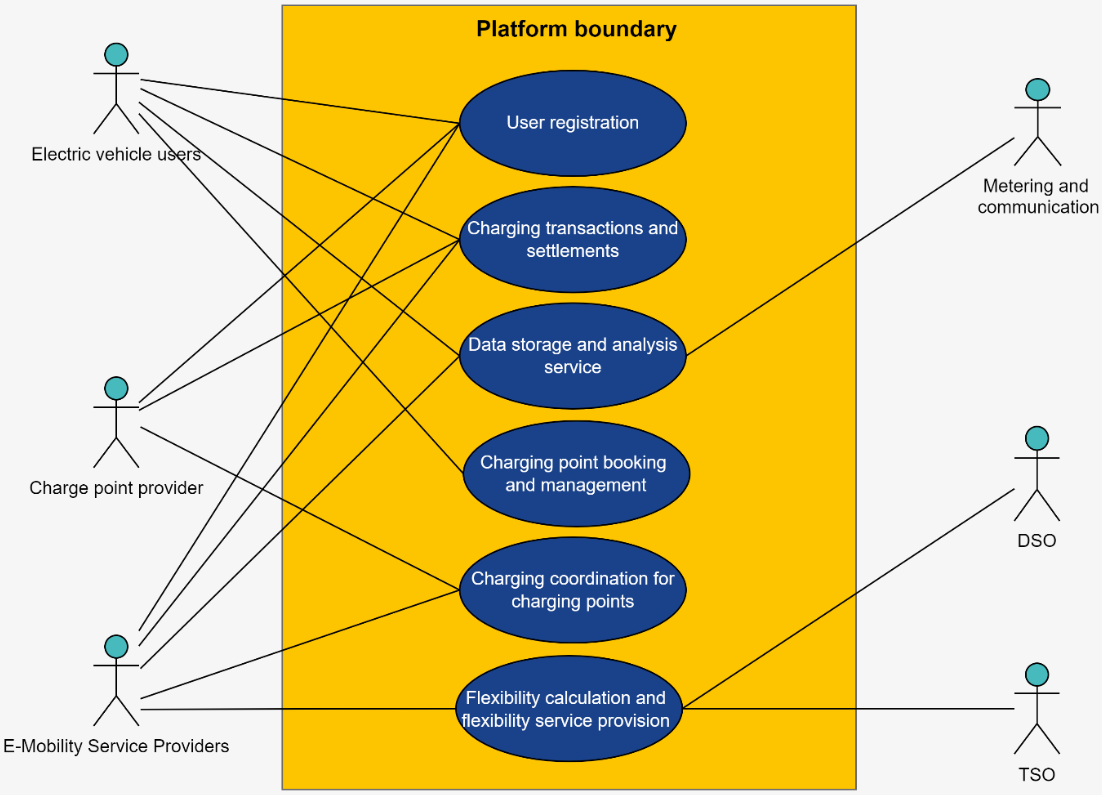

Figure 3.5-2. Diagram of the use case 5.

3.5.5 Actors of the use case

Table 3.5-3. Description of the actions of use case 5 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Metering and communication devices	System	Devices used to record specific types of data and communicate those data to the platform.	Meters at charging points record the energy consumption data and send them to the data storage system in the platform.	No
EV users	Role	The owners of EVs.	EV owners register in the platform, share their location data, and receive offers from charging points close to the location of their requested location. They can also manage their booking. In the end, they receive the invoice for the service.	No

EMSP	Role	EMSPs are companies that offer services related to EV charging. They typically focus on providing users with access to a network of charging stations, which may include routing, access and payment solutions, roaming, value-added, and customer support services.	EMSP accepts the registration of new devices, performs the calculations of charging cost, applies charging coordination methods, calculates flexibility, and offers it to the ancillary service markets.	No
CPP	Role	The operator of the charging station. Modern charging stations from CPPs collect detailed data on energy consumption, usage patterns, and grid interactions. This data is invaluable for CPOs in predicting energy needs and optimizing procurement strategies.	CPP registers in the platform, provides the availability data of charging points to the platform, receives charging coordination service from the platform, and information about charging transactions.	
TSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	Receives flexibility bids from EMSP.	No
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	DSOs can receive location-based flexibility offers and services from EMSP, as well as information about the available capacity from the EMSP to ensure stable grid operation.	No

3.5.6 Scenarios

Table 3.5-4. Description of use case 5 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.05.S1	User registration	An EV or CPP joins the platform	When an EV or CPP request for using the platform, the related information is received and registration is completed.	EV owner or CPP
BEG.05.S2	Charging transactions	At the end of charging an EV	After the period of charging ended, the total cost is calculated considering the	EMSP

	and settlements		price type selected by EV owner, and the invoice is sent to the EV owner.	
BEG.05.S3	Data storage and analysis service	The data from CPP or EV is received	Provides services for storing the data of EVs and CPPs and analyzing the data for instance based on EVs or CPPs geographical location. These analyses can be used later for calculating flexibility in different locations in the grid.	EMSP
BEG.05.S4	Charging point booking and management	EV owner decides to charge the car	EV owner checks the options and book a charging point. He/she can also manage the booking i.e., cancelling or changing the parameters.	EV owner
BEG.05.S5	Charging coordination for charging points	When a new EV books a charging point or a flexibility service is provided	The platform provide charging coordination service for CPPs. This charging coordination can be for minimizing the total cost or providing grid services.	EMSP
BEG.05.S6	Flexibility calculation and flexibility service provision	Continuous, in specific time intervals	Based on data received from EV owners, available flexibility is calculated and offered to the ancillary service market. Prediction methods can estimate available flexibility for the next day if required to offer flexibility in a day-ahead manner.	EMSP

3.5.7 Policy and digitalisation needs

Table 3.5-5. Description of use case 5 policy and digitalisation needs.

Policy needs	The main policy concerns for this use case are about data sharing. • Data-sharing agreements must be made with renewable energy producers, EVSE and mobility fleet owners, or traffic operators, considering GDPR. • Regulations are required to allow data sharing among stakeholders. • There are concerns about if the companies are willing to share their internal data such as the produced energy, the energy consumption from EVSEs, and the daily route and charging habit of their EVs, • Regulations are required to allow the participation of the EMSP as aggregators in ancillary service markets.
Digitalisation needs	Digitalization needs for this use case primarily include the access of the ODP to • Real-time and historical data of the renewable energy producers, EVSE, and mobility fleet owners. • Communications channel to EV users (like the fleet's or traffic management's mobile apps).

3.6 Use case 6: A cross-border recommender tool and flexibility procurement mechanism for grid services

3.6.1 Use case identification

Table 3.6-1. Identification of use case 6.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.06	A cross-border recommender tool and flexibility procurement mechanism for grid services	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☒ Transmission ☐ Generation	☐ Customer information ☒ Vehicle ☒ Energy station ☒ Infrastructure ☐ Traffic and logistic	☒ Edge ☐ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.6.2 The scope and objectives of the use case

Table 3.6-2. Scope and objectives of use case 6.

Scope and Objectives of the Use Case	
Scope	The goal of this use case is to introduce an ODP for facilitating the cross-border participation of CLs and end-user customers in distribution and transmission grid services. The ODP allows different types of CLs to connect the platform directly or indirectly via aggregators. It also allows the customers to react to ODP calls for services manually via mobile apps. Two types of services are defined for the ODP, 1) a recommender service that analyzes the supply and demand at each state and determines how vulnerable the grid is and sends recommendations to loads and end-users to prevent imbalances or cutting the output power of RESs, 2) a balancing service that acts as a aggregator in EU level that is used as a tool parallel with existing mechanisms to provide ancillary services for TSOs and DSOs. Allowing cross-border flexibility trading provides market opportunities for aggregators and demand-side flexibility and reduce the costs of procuring flexibility from traditional resources.
Objective	The main goals of the use case are as follows: • Introducing a mechanism for procuring demand-side flexibility at the EU level taking into account the existing mechanisms, • Proposing a recommender service for analyzing the grid vulnerability and benefiting from demand-side flexibility for preventing power imbalances and RESs' power cuts, • Proposing a tool for aggregation and classification of the demand-side flexibility at the EU level, • Providing new market opportunities for aggregators, • Reducing the need for conventional flexibility resources, • Providing services for TSOs and DSOs.
Reference country(ies)	Denmark
Related Business Case	E. g. Distribution grid operation, transmission system operation, load aggregation, flexibility market
Possible stakeholders	Aggregators, TSOs, DSOs, end-user customers,

3.6.3 Narrative of the use case

European electric power systems are undergoing important changes. With the adoption of the European Green Deal, the EU aspires to become the world first's climate-neutral continent by 2050 [15]. RESs are the key driver for achieving this goal. Due to the unpredictable nature of RESs, the power system needs innovative solutions to continue keeping energy injections and withdrawals in balance instantaneously, ensuring a stable and secure operation. On the other hand, increased penetration of RESs in the distribution grid level together with electrification of heat and transport sectors are posing challenges to the distribution system operation. So, both transmission and distribution systems are affected by new changes in power system generation and consumption.

To overcome these issues two types of actions can be taken, 1) prevent the issues from happening as much as possible, and 2) react fast enough to reduce and mitigate the impacts of issues. Taking preventive actions not only reduces the stability risks of the grid but can also be cost-effective by reducing the need for reserves and preventing the RES output power cuts.

In addition to the existing mechanisms for grid services, demand-side flexibility is introduced as a promising solution for balancing the power system and solving distribution grid issues. Any controllable device such as EVs, HVAC systems, batteries, etc. can contribute to flexibility services. Since demand-side flexibility is small in scale and large in number, aggregation and coordination mechanisms are used by aggregators, and then the aggregated flexibility can be offered to the DSO or TSO. The point is that TSOs' ancillary service markets of different countries act in an independent manner, which allows the aggregators to be in contact with one TSO. This limits market opportunities for CLs and aggregators. Also, regulations might not allow them to provide grid services in some countries while other countries could be open to demand-side flexibility. On the other hand, providing the possibility of interaction between aggregators and TSOs in different countries and looking into the congestion and balancing issues as problems at the EU level can facilitate solving these issues. Even when the ancillary services are procured in a central way in the EU, the proposed flexibility capacity of many aggregators might not be enough to participate in these markets due to the regulations on minimum capacity. In this case, a re-aggregation of aggregators' capacity can be useful for both TSOs and aggregators.

DSOs can also benefit from interaction with different aggregators and CLs in their area to solve distribution grid issues.

Considering all the above explanations, a use case is defined to develop a cross-border ODP for providing the following services:

- A recommender service that sends recommendations to the CLs directly (via mobile apps or energy management systems (EMS)) or indirectly (via aggregators) to inform about the vulnerability of the grid at each member state or region and ask for suitable reaction to reduce the risk of occurring any issues or cutting output power of RESs. The risk assessment is done using historical and real-time data and applying advanced data-driven and AI-driven methods,

- A demand-side flexibility procurement service for solving distribution or transmission grid issues at the EU level. This service aggregates and classifies the flexibility capacity of the devices that are connected to this service directly or indirectly and uses them to solve grid issues.

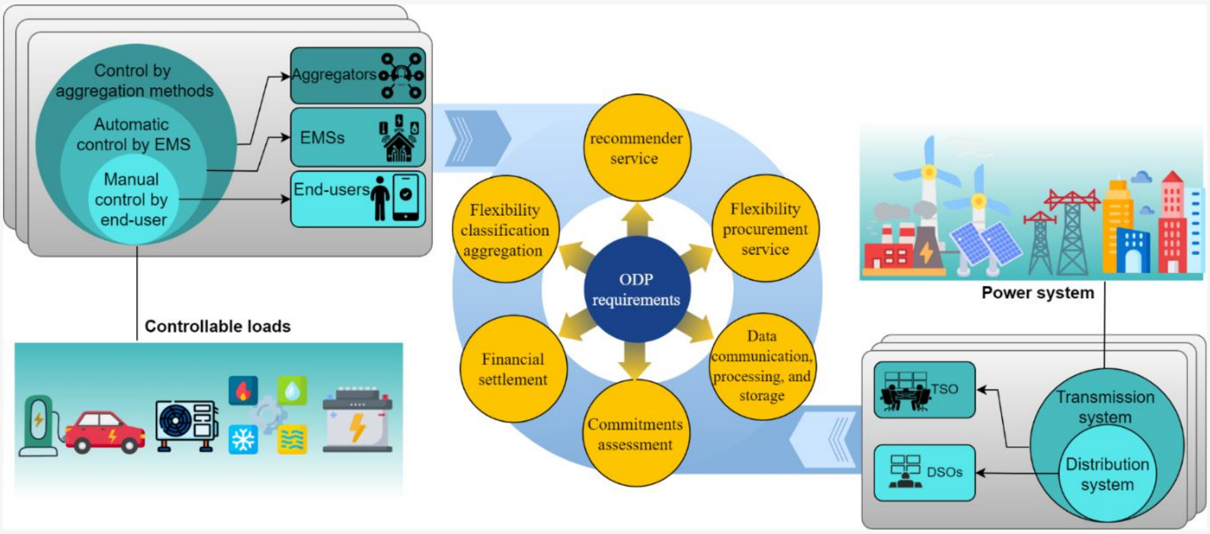

Figure 3.6-1. Requirements of the proposed ODP for use case 6.

A block diagram of the use case requirements is presented in Figure 3.6-1. The ODP allows access to any user including end-user customers that can interact with ODP manually via mobile apps, controllable devices connected to EMSs, and aggregators that control a group of devices. End-users that connect to the platform via the mobile app are suggested to participate only in the recommender service voluntarily. This is because these devices are not connected to the platform and their operation cannot be assessed and included in the technical and financial transaction. CLs and aggregators can participate in both above-mentioned services, So, in addition to receiving recommendations for changing their power consumption, they should also report their available flexibility capacity and respond to flexibility requests received from the platform. This needs some hardware and software requirements at the device level that should be considered.

Since some of the services are location-based such as congestion management or voltage regulation, when a new device is added to the system, its geographical data should be registered. This data should be stored at the member state level and is not shared among member states. Also, the detailed flexibility capacity of each device should not be shared among states and only the aggregated values should be reported. These considerations are for data security and privacy reasons.

Any DSO or TSO at the EU level can get connected to this ODP. DSOs can receive location-based services. However, TSOs can receive balancing services from any device in the synchronous area. The power transfer capacities between member states should also be considered when flexibility is procured in a cross-border way.

A financial settlement method should be defined to incentivize aggregators and end-users to join the ODP. Additionally, an evaluation method is required to assess the commitment of users to their obligations.

3.6.4 Diagram of the use case

The diagram of the use case 6 is presented in Figure 3.6-2. Actors' actions and scenarios' descriptions are presented in Table 3.6-3. and Table 3.6-4., respectively.

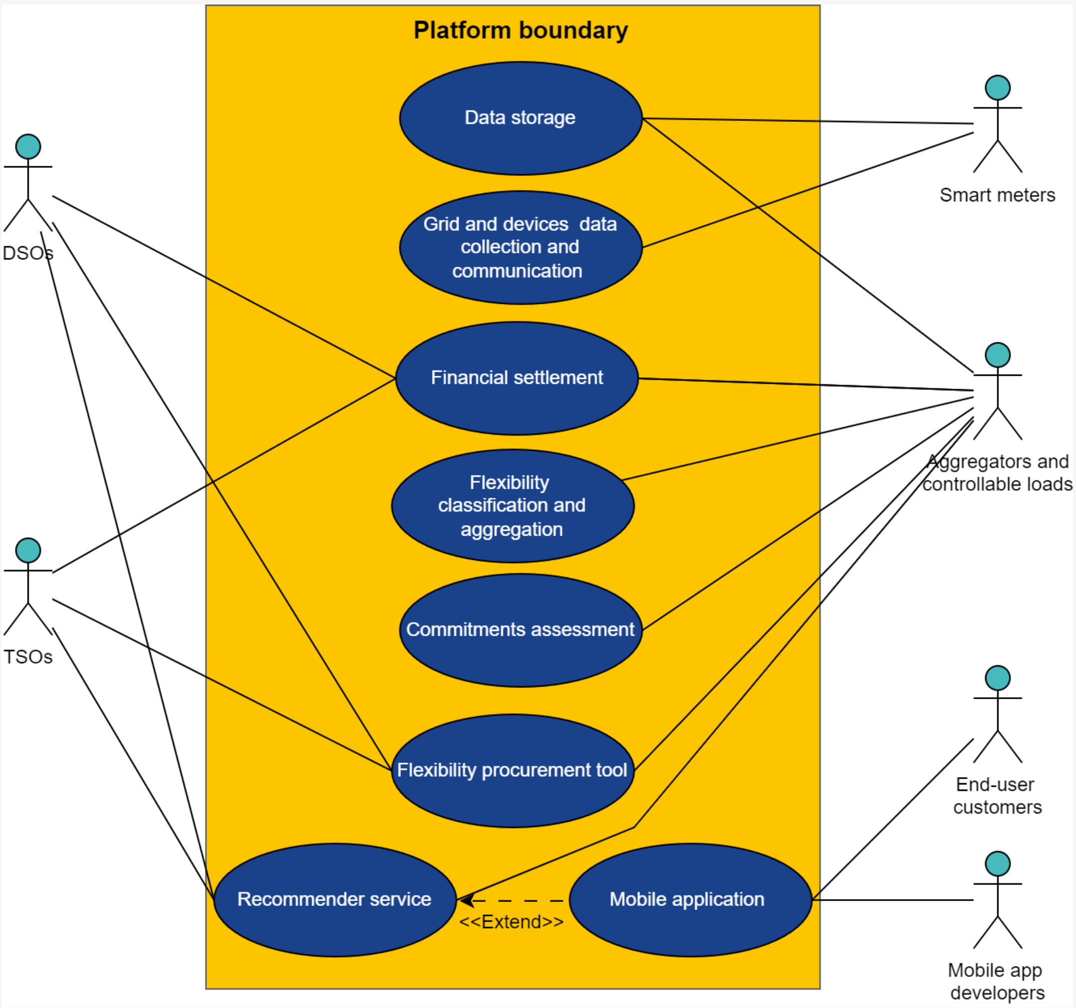

Figure 3.6-2. Diagram of use case 6.

3.6.5 Actors of the use case

Table 3.6-3. Description of the actions of use case 6 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Smart meters	System	A smart meter is an electronic device that records information and communicates the information to a supplier.	Smart meters record grid and controllable devices and send the measurements to the data storage.	No
Aggregators and CLs	Role/system	An aggregator pools electricity supply and/or demand and sells this capacity in the electricity markets. A controllable device is an electric device that its power consumption can be controlled by control signals.	Aggregators and controllable devices report their available flexibility capacity to the ODP and receive recommendations when the grid is at risk and flexibility requests when an incident occurs.	No
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	DSOs monitor their grid and collaborate with ODP in providing recommender and flexibility services. They also contribute to the financial settlement of flexibility services.	No
TSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	TSOs monitor transmission systems and collaborate with ODP in providing recommender and flexibility services. They also contribute to the financial settlement of flexibility services.	No
End-user customers	Role	The final consumers of electricity.	They receive recommendations via mobile apps and react manually and voluntarily	No
Mobile app developers	Role	Companies that develop mobile applications	They develop mobile apps that allows end-users to receive notifications of grid status and react	No

3.6.6 Scenarios

Table 3.6-4. Description of use case 6 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor

BEG.06.S1	Grid and device data collection and communication	Continuous	The grid and device parameters are recorded and sent to the data storage	Smart meters
BEG.06.S2	Data storage	When new data is received	Data is preprocessed and stored in the data center	Smart meters
BEG.06.S3	Flexibility classification and aggregation	A flexibility capacity is announced by aggregators or controllable devices	Flexibility capacity of the aggregators and controllable devices for a specific period is aggregated and classified based on location	Aggregators and controllable devices
BEG.06.S4	Commitments assessment	After providing a service	After the period of flexibility provision, the accuracy of following the commitments is evaluated	Aggregators and controllable devices
BEG.06.S5	Flexibility procurement tool	Continuous, when flexibility is needed	A tool needs to be developed to determine how the flexibility should be procured considering the available capacities.	TSO/DSO
BEG.7.S6	Recommender service	When the system is in potential stability and reliability risks	Data-driven and AI-driven methods are used to measure the vulnerability of the system and send recommendations to users	TSO/DSO
BEG.7.S7	Financial settlement	After providing a service	Considering the procured flexibilities and agreed prices, the financial settlement is done.	TSO/DSO
BEG.7.S7	Mobile application	Once when the platform is developed	A mobile app is developed for end-user customers to participate in the recommender service	Mobile app developers

3.6.7 Policy and digitalisation needs

Table 3.6-5. Description of use case 6 policy and digitalisation needs.

Policy needs	• New policies for facilitating the participation of demand side and aggregators in ancillary service markets, • Ensuring the possibility of sharing flexibility data among EU member states, • Defining a mechanism for measuring the flexibility provided by CLs and aggregators
Digitalisation needs	• Providing the possibility of data communication between all market players and the platform, • Interoperability of different ODP components, • Affordable hardware and software tools for CLs to interact with ODP

3.7 Use case 7: A unified way for changing the energy service provider in EU member states

3.7.1 Use case identification

Table 3.7-1. Identification of use case 7.

ID			Cross-sector domains	

	Name of Use Case	Geographical scope	Electric	Mobility	Data	Interoperability layers
BEG.07	A unified way for changing the energy service provider in EU member states	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☒ Customer ☐ DER ☒ Distribution ☐ Transmission ☐ Generation	☒ Customer information ☐ Vehicle ☐ Energy station ☒ Infrastructure ☐ Traffic and logistic	☐ Edge ☐ Fog ☒ Cloud	☐ Component ☒ Communication ☒ Information ☐ Function ☐ Business

3.7.2 The scope and objectives of the use case

Table 3.7-2. Scope and objectives of use case 7.

Scope and Objectives of the Use Case	
Scope	In most countries around the EU, the change of providers is a multi-stage process that requires time and human involvement at some of the stages making the process slow and expensive. The goal of this use case is to develop a cross-border ODP for automated switching of energy providers that allows an energy consumer to change an energy supplier within 24 hours with guaranteed safety of their data. The focus of this ODP is to ensure all involved parties securely exchange data by sending minimum required sensitive information while limiting the human intervention to the customer choosing the new energy supplier via ODP microservice. The compliance with communication standards, accuracy, and safety of data exchange between the responsible parties are the primary challenges that the platform addresses and reconciles between different member states. For example, the ODP through the use of microservices addresses the difference in the structure of the energy market in Denmark where the responsibility structure is slightly different and has potentially shorter communication channels than in Germany. In the latter, the communication would primarily include the consumer, their DSO responsible for the physical infrastructure, the electricity supplier (ES) responsible for service delivery, and the Metering point operator (MPO) responsible. There is a potential for this ODP to be useful for ES and energy data managing parties when working with the end-customer data.
Objective	The objectives of the use case are as follows: • Introduce a set of fast and safe processing of consumer and utility data. • Enable an interface for all parties involved in the change of providers where they can see and change the status of existing subscriptions based on customer input. • Introduce a role-based decentralized communication service between the consumer, utility, and intermediate parties involved in the process of changing the provider with minimal information exchange. • Enable a secure and fast customer verification process that can be used in the target countries. • Create an app for service providers to coordinate the subscription processes. • Keep the platform in agreement with regulations from target countries.
Reference country(ies)	Germany, Denmark

Related Business Case	MakoMaker Space
Possible stakeholders	Retailers and energy suppliers, end-user customers, TSOs, DSOs

3.7.3 Narrative of the use case

The mechanics of utility subscription change in the EU member states may be quite different in the energy market structure and data-handling regulations. In most countries around the EU, the change of providers is a multi-stage process that requires time and human involvement at some of the stages making the process slow and expensive [16]. The attempted automation of the supplier change process brings additional challenges that include synchronization and algorithmizing of contract creation and termination processes that involve manual intervention and often iterative documentation transfer between TSOs/DSOs, metering point operators (MPOs), and Energy Suppliers. This calls for a solution that reconciles different traditions accepted in target member states to enable an automated, secure, and regulation-compliant process for chainging the energy service provider within 24 hours that will benefit both energy delivery parties, energy consumers, and authorities while going one step further in unification of the energy infrastructure thought EU. The use case aims to develop the ODP platform that satisfies these requirements while processing and communicating consumer data between the stakeholders in a sovereign, fast, and secure way.

The development of the platform will start by resolving the following design questions primarily related to the physical infrastructure and responsibilities of parties to be answered in collaboration with the stakeholders:

- Would the supplier that is chosen by a consumer across the border be allowed to participate in the foreign energy market? Which regulations should the associated DSOs follow about such consumers changing their subscriptions: domestic or foreign?
- How would the capacities and added electricity consumptions be reported across the border?
- Concerning supplier participation in the foreign market, how is the data transferred to them from the consumers? Are the same privacy regulations applying in both countries or should be reconciled?
- What scenarios can be used to define the interaction between TSOs, ES, and end users?

After these questions are resolved, the ODP will enable automated documentation updates in response to the ES changing request with physical infrastructure and market participation details fixed by the prior agreements between the TSOs in both countries. At the same time, the platform will have the functionality for manual conflict resolution in certain situations.

As illustrated in Figure 3.7-1, after the provider change request is sent to the platform from the user (e.g. red electricity consumer in Germany), the contract creation request is initiated and sent to the new supplier (e.g. green ES in Denmark). If the request complies with the requirements of the new supplier, the contract termination notification is sent to the old (red) provider, and the new energy contract is created and sent back to the (red) consumer. At the same time, the information is sent to the TSO, DSO, and MPO subsystems to set up the service records for the new consumer. If any remaining regulation, electricity market participation, or data management conflicts are detected by the TSO service, they are resolved semi-manually with all relevant stakeholders. After all conflicts are resolved, the document base for the consumer is updated for all relevant stakeholders.

Figure 3.7-1. Illustration of the energy supplier change process.

3.7.4 Diagram of the use case

The diagram of the use case 7 is presented in Figure 3.7-2. Actors' actions and scenarios' descriptions are presented in Table 3.7-3. Table 3.7-3. Description of the actions of use case 7 actors.and Table 3.7-4., respectively.

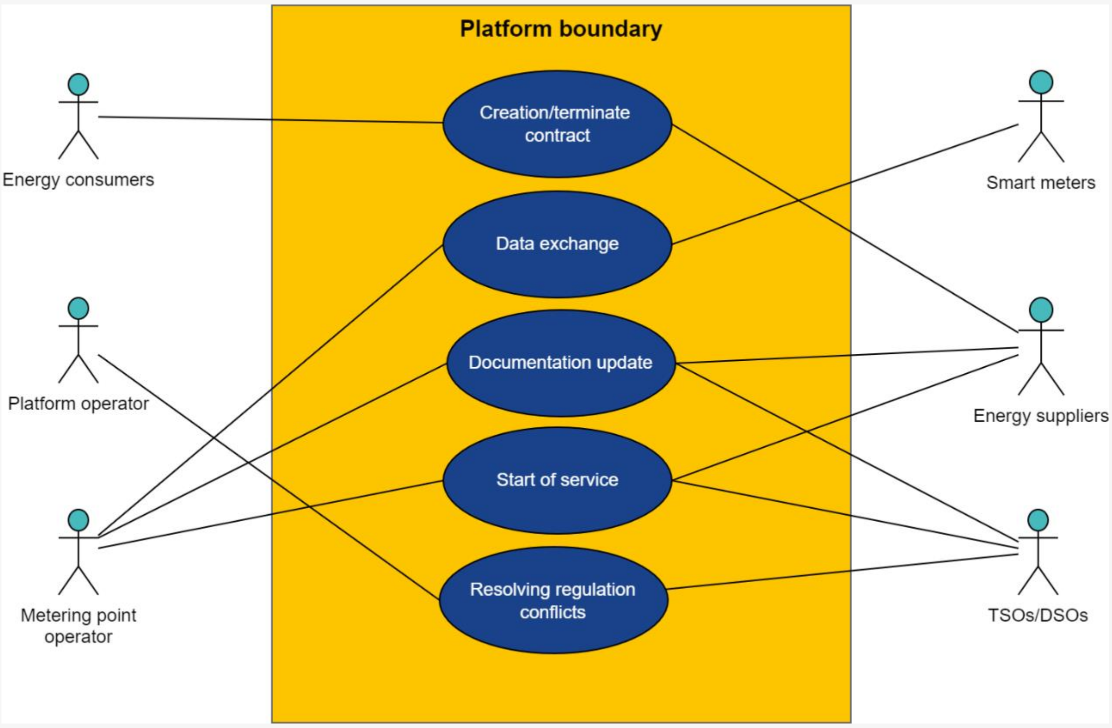

Figure 3.7-2. Diagram of use case 7.

3.7.5 Actors of the use case

Table 3.7-3. Description of the actions of use case 7 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Smart meter	System	A smart meter is a digital device that measures and records energy consumption in real-time.	Measures the electricity consumption of energy customers.	No
Platform operator	Role	A platform operator is a person or organization that is responsible for operating a platform and resolving the users' issues.	Ensures communication and automation of tasks for TSOs, DSOs, MPOs, and other parties responsible for changing the contracts safely and lawfully. It also provides a possibility for semi-automated conflict resolution as a decision-support tool.	No
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	In states where the agreement with DSO is needed to change the ES, DSO ensures that the new cross-border consumer has the necessary infrastructure to get the service from the cross-border service provider within its area of responsibility.	No
TSOs	Role	An entity responsible for operating, ensuring the	TSOs decide on how to resolve the task and possible conflicts related	No

		maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	to the provision of power to the new cross-border consumers by using the proposed platform.	
Metering point operators	Role	MPO is responsible for operating and maintaining the metering equipment that measures the consumption and generation of electricity at a specific location, known as the metering point.	Ensures that the installed meters meet regulations necessary to enable service according to agreement between the TSOs and member states' regulations. This includes accuracy and safety for meter data reading and aspects related to transmitting this information to other actors: energy suppliers, grid operators, and consumers.	No
Energy supplier	Role	A person or company that is consuming a certain amount of energy within one of the member states that would like to change the request for the change of power supplier within the platform and for operating different tools and services in the platform.	ESs Receive the request for changing ESs from the customers, check the regulations for the possibility of supplying new customers, finalize the contract, and participate in the electricity market to supply the new customers.	No
Energy consumer	Role	A person or company that is a power consumer in one member state that would like to switch their supplier to that located in the neighboring state.	Sends the request through the platform for changing the ES from domestic to foreign or back. Agrees to conditions of GDPR practices accepted in the two member states and agrees on the provision of their metering data necessary for different parties to process the provider change request and conflict resolution between different TSOs.	No

3.7.6 Scenarios

Table 3.7-4. Description of use case 7 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.07.S1	Creation and termination of contracts	The consumer sends the new ES the contract creation request.	The ES contract request from the consumer is processed automatically by the platform and if there are no conflicts, the approval is sent back to the consumer and the termination notification is sent to the old ES. After this, the new contract is sent to the consumer.	EC, Platform operator

BEG.07.S2	Data exchange	Continuously	The energy consumption data should be recorded by smart meters and transferred to the related supplier database to calculate the electricity bill.	MPO, Smart meter
BEG.07.S3	Conflict resolution	Termination request is sent to the old ES	Cloud Platform (re)registers the new consumers in the cross-border TSO database including the way of delivering the service and energy market participation mechanism agreed between the TSOs and Energy Supplier. In case of uncertainty, the system notifies the actors and waits for conflict to be resolved by them. After the scenario is completed, the notification (and possibly new information) is sent to the DSO/MPO system.	Platform operator, TSO
BEG.07.S4	Updating documentation storage with new consumer data	TSOs send the decision after resolving conflicts	MPO and DSO documentation is updated, and the platform ensures that all parties have the most recent information and documentation related to the consumer's subscription to the service.	MPO
BEG.07.S5	Set up/Start of service for the consumer at the new provider's level	All documentation for consumers is updated.	The actors start serving the consumer and the consumer starts participating in the energy market under the rules defined by the TSO/ES, e.g. the new data communication channel is launched that supplies information from consumer meters (managed by MPO) to the cross-border ES.	DSO, MPO, EC.

3.7.7 Policy and digitalisation needs

Table 3.7-5. Description of use case 7 policy and digitalisation needs.

Policy needs	• The TSOs need to agree on which market the new consumer would participate in. • Find ways to reconcile the national traditions/regulations concerning consumer data treatment policies and GDPR. • Regulations are needed to create options for solving technical and financial issues for supplying the end user (used in market interaction scenarios between TSOs, ES, and users).
Digitalisation needs	• Define a common interface for member states that includes documents and algorithms for formal communication. • Automate the process of iterative documentation flow and conflict reconciliation between stakeholders.

3.8 Use case 8: Cross-border virtual communities of RESs and CLs

3.8.1 Use case identification

Table 3.8-1. Identification of use case 8.

ID			Cross-sector domains	

	Name of Use Case	Geographical scope	Electric	Mobility	Data	Interoperability layers
BEG.08	Cross-border virtual communities of RESs and CLs	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☒ Vehicle ☐ Energy station ☒ Infrastructure ☐ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.8.2 The scope and objectives of the use case

Table 3.8-2. Scope and objectives of use case 8.

Scope and Objectives of the Use Case	
Scope	This use case aims to propose a cross-border platform for creating a virtual community of RESs and CLs such as EV charging stations, batteries, and HVAC systems to facilitate green transition. Through this platform, CLs on the demand side are involved in automated power trading with RESs with agreed prices. The excess production of RESs or the extra demand of the CLs that are not settled in the platform should be sold or purchased in the day-ahead and intraday markets, respectively. Hence, the whole platform can participate in the electricity market as a single market player. The platform will also allow EV owners to find the charging points that are members of this platform and charge their EVs with green energy.
Objective	The main goals of the use case are as follows: • One of the main objectives of this use case is to facilitate the engagement of end-users in green transition and incentivize them to have an active role in increasing the share of RESs, • Another objective is to reduce the uncertainties caused by RESs by aggregating them and utilizing the flexibility of CLs, • The platform can create a market environment for trading the power of RESs, • Utilizing the method reduces the number of market players and consequently the complexities of running electricity markets, • Aggregating the RESs and CLs reduces the need for balancing reserve and consequently operation costs, • The platform provides a tool for EV owners to charge their cars with RESs at competitive prices.
Reference country(ies)	Denmark, Sweden
Related Business Case	Renewable energy operation, demand side management, Charging station management
Possible stakeholders	RESs, charging stations, and HVAC load owners. Facilities with CLs, EV owners

3.8.3 Narrative of the use case

The EU aims to be climate-neutral by 2050 [15]. This means a significant increase in RES investment. Despite the benefits of RESs, their output power is uncertain and this makes it difficult to bid their output power in electricity markets. Additionally, the imbalances that are caused by RESs can create reliability and stability issues for the grid and financial losses for RESs. In general, there are two main solutions for this issue, 1) aggregating RESs as a single unit and participating in the electricity markets, and 2) joining RESs with CLs to damp their output power fluctuations and increase their predictability.

The proposed use case aims to achieve both objectives by developing a platform that is capable of registering different types of RESs, e.g., PV and wind, and different types of CLs such as charging points of EVs, batteries, and HVAC systems. Charging stations are chosen due to the high electricity demand and the flexibility they can provide in charging the EVs. HVAC systems consume approximately 40% of total building energy and are equipped with energy management systems which makes them controllable [17].

The platform has different advantages. First, it can be a useful tool for people who are interested in green energies and would like to be supplied by RESs. So, it can facilitate social engagement in green transition. From the technical point of view, joining the RES and loads can decrease the unpredictability of RESs. This reduces the challenges for operating electricity markets and also reduces the need for balancing reserves.

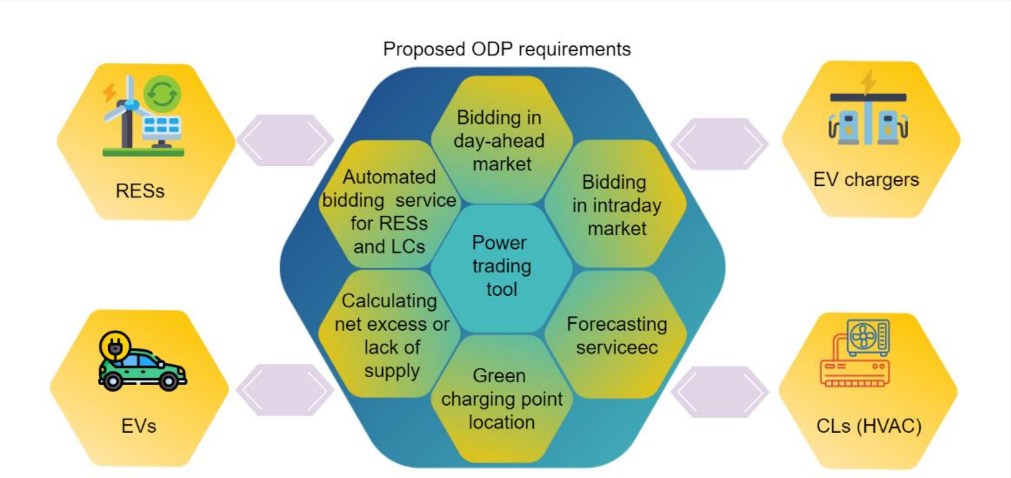

Figure 3.8-1. The framework of the use case 8.

The platform workflow is illustrated in **Error! Reference source not found.**. RESs predict t heir output power and CLs predict their consumption for the next day. The bids and offers are submitted to the power trading tool and settled. The excess production or demand is calculated and submitted to the day-ahead market. Close to real-time, the forecasts and values of traded powers are updated accordingly, and the updates in the excess production or demand are settled in the intraday market. The power trading tool can use different mechanisms for trading power such as the pool-co approach or P2P trading.

The platform is designed in such a way that the maximum flexibility potential of the CLs is used to minimize the excess production or demand. After closing the intraday market, the sudden changes in the RESs and deviations from the scheduled powers are tried to be balanced using the flexibility of loads. It should be noted that all CLs should be equipped with optimal controllers and energy management units that satisfy their operational constraints. EVs can use the database of the platform to know which charging stations are supplied by green energy and their prices.

Advanced AI-driven methods are required for developing forecast tools for RESs, EV charging stations, and HVACs. Additionally, AI-based approaches should be used for automated power bidding. Both of these tools can be provided by the platform as services taking into account the owners' preferences. To assess the commitment of the market players in producing or consuming the scheduled power and providing the forecast services it is necessary to record the data at customers' nodes and send them to a database in the platform. Since transmission and distribution system tariffs should be considered in the cost, agreements with TSOs and DSOs are required to include those costs in the customers' final prices.

3.8.4 Diagram of the use case

The diagram of the use case 8 is presented in Figure 3.8-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table 3.8-4., respectively.

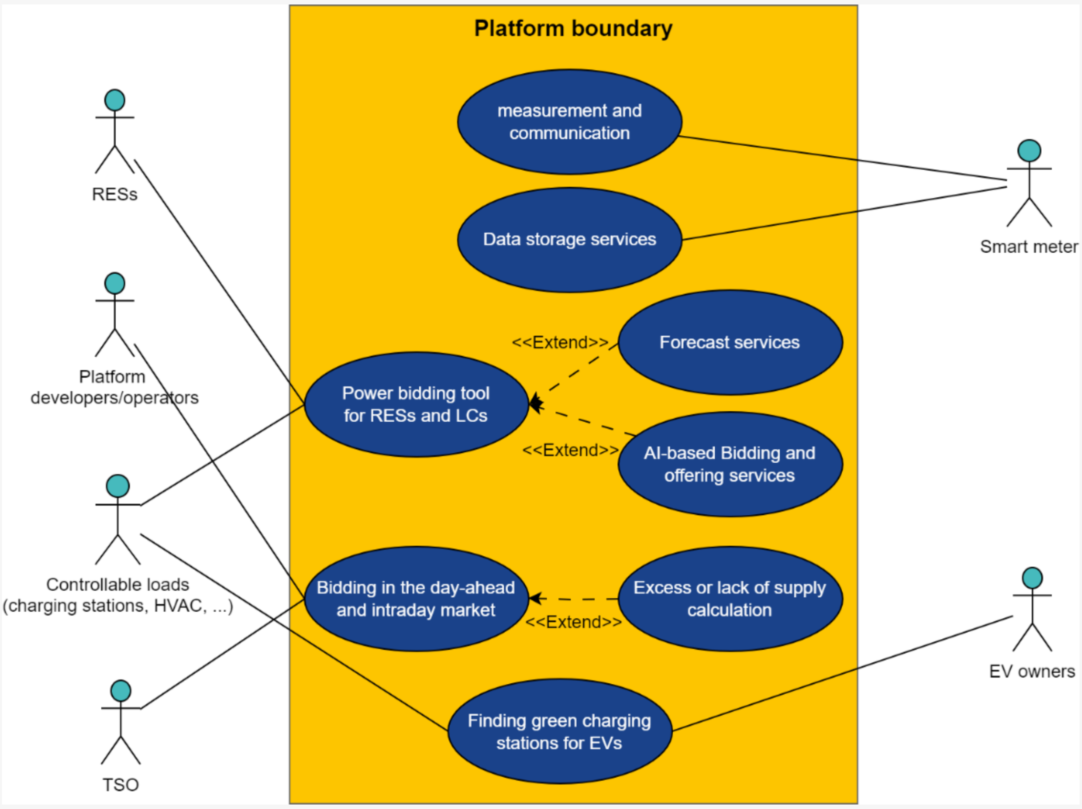

Figure 3.8-2. The diagram of the use case 8.

3.8.5 Actors of the use case

Table 3.8-3. Description of the actions of use case 8 actors.

Actor Name	Actor Type	Actor description	Actions	Standards

Smart meter	System	A device that is capable of recording and communicating data with databases	Smart meters record data from devices and RESs and send them to data storage to be used for forecasting and other services.	No
RESs	System	RESs such as wind and solar power	RESs use forecast results and bidding in P2P trading with CLs.	No
CLs	Role	CLs are referred to the devices with manageable energy consumption.	CLs use forecast results and offer in power trading with RESs.	
EV owners	Role	The owners of the EVs	Use ODP to find charging stations supplied with green energy.	No
Platform developers/ operators	Role	Persons or companies that are responsible for maintaining and running sdervices in the ODP	They use services that calculate net excess or lack of supply in the ODP portfolio and participate in the day-ahead or intraday markets to balance the portfolio.	No
TSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	TSO receives bids and offers from the ODP.	No

3.8.6 Scenarios

Table 3.8-4. Description of use case 8 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.11.S1	measurement and communication	Continuous, in specific time intervals	Parameters of the devices and RESs are measured and communicated with ODP	Smart meters
BEG.11.S2	Data storage services	When new data is received	Data is received from smart meters, processed and saved	Smart meters
BEG.11.S3	power trading tool for RESs and CLs	Continuous, in specific time intervals	A tool that receives bids and offers of RESs and CLs and determines accepted bids using a market mechanism	RESs and CLs
BEG.11.S4	Forecast services	Submitting a bid or offer is required	A service that uses historical data of RESs and CLs to predict their	RESs and CLs

			output power and consumption, respectively.	
BEG.11.S5	AI-based Bidding and offering services	Submitting a bid or offer for power trading is required	Using the forecast results, RESs and CLs use this tool to submit bids and offers for trading power in the ODP	RESs and CLs
BEG.11.S6	Bidding in the day-ahead and intraday market	Dayahead or intraday market opens	The net excess or lack of supply in ODP is submitted to the day-ahead and intraday markets	Platform developers/ operators
BEG.11.S7	Excess or lack of supply calculation	Submitting a bid or offer to day-ahead or intraday markets is required	Calculating the unsettled powers in the ODP portfolio	Platform developers/ operators
BEG.11.S8	Finding green charging stations for EVs	EV owners looking for green charging stations	The EV owners can have access to the platform for example through a mobile app and find the location of charging stations supplied by green energy.	EV owners

3.8.7 Policy and digitalisation needs

Table 3.8-5. Description of use case 8 policy and digitalisation needs.

Policy needs	• As end-users are one of the core elements in developing the grid's digital twins, end-users should be ensured that the privacy of their data is preserved. Policies should be in place to guarantee that user data is securely stored and only used for its intended purposes. • In case the platform is used by different states, the policies for storing data in different member states should be considered.
Digitalisation needs	• Interoperability between different elements of the platform.

3.9 Use case 9: Mobility 3.0

3.9.1 Use case identification

Table 3.9-1. Identification of use case 9.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	

BEG.09	Mobility 3.0	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☐ Customer ☐ DER ☐ Distribution ☐ Transmission ☐ Generation	☒ Customer information ☒ Vehicle ☐ Energy station ☐ Infrastructure ☒ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.9.2 The scope and objectives of the use case

Table 3.9-2. Scope and objectives of use case 9.

Scope and Objectives of the Use Case	
Scope	The Mobility 3.0 use case aims to revolutionize traffic management by leveraging the DGT 3.0 platform from Spain. This platform serves as a centralized hub for real-time traffic information, enabling seamless communication among various stakeholders in the mobility ecosystem. By integrating data from sources such as vehicle sensors, roadworks notifications, and special transport vehicles, Mobility 3.0 provides comprehensive insights into road conditions and potential hazards. Through collaborative efforts between manufacturers, service providers, and government agencies, the goal is to enhance road safety, optimize traffic flow, and improve overall mobility experience. With a focus on standardization and privacy protection, Mobility 3.0 seeks to establish a robust framework for sharing and consuming mobility data, fostering innovation and efficiency in the transportation sector.
Objective	• Offer real-time traffic updates to drivers, facilitating informed decision-making and improving road safety. Integrate platform services seamlessly into vehicles for enhanced user experience. • Provide alerts and warnings to drivers, reducing accident rates and ensuring the safety of all road users. • Improve travel efficiency by offering route recommendations and traffic management strategies. Support vehicle fleet managers in optimizing operations through data-driven insights and efficient route planning. • Equip road managers with comprehensive traffic data for effective management, including congestion identification and targeted interventions. Ensure authorities benefit from improved traffic flow and reduced congestion-related issues through data-driven decision-making. • Implement robust data privacy measures to safeguard driver information and ensure regulatory compliance. Assure vehicle manufacturers of data security measures to encourage collaboration and integration with the platform.
Reference country(ies)	Spain and Portugal
Related Business Case	Road maintenance, Traffic management, Smart Routing
Possible Stakeholders	Vehicle Manufactures, Infrastructure Operators, Governmental Bodies, Fleet Operators, Vehicle owners.

3.9.3 Narrative of the use case

This use case is a real implementation in the Spanish traffic congestion management. With the rise of digitalization, there's a pressing need for innovative solutions to revolutionize traffic management and enhance road safety. Enter Mobility 3.0, a groundbreaking platform developed by the Directorate-General of Traffic (DGT) of Spain aimed at transforming the way we navigate our cities.

Addressing Traffic Challenges with Digital Solutions

Traffic congestion is a pervasive issue in modern cities, resulting from a myriad of factors such as population growth, urbanization, and inadequate infrastructure. Traditional traffic management approaches struggle to keep pace with the dynamic nature of urban mobility, leading to inefficiencies and suboptimal road usage. To tackle these challenges, Mobility 3.0 leverages the power of digitalization to create a seamless and intelligent traffic management ecosystem.

A Unified Platform for Mobility Solutions

Mobility 3.0 serves as a centralized hub for all stakeholders involved in urban mobility, including drivers, road authorities, vehicle manufacturers, and transportation service providers. By harnessing real-time data from vehicles equipped with Vehicle-to-Everything (V2X) communication capabilities, the platform gathers valuable insights into traffic conditions, road hazards, and infrastructure status. This data forms the foundation for smart decision-making and proactive traffic management strategies.

Services Offered by Mobility 3.0

- **Incident Reporting and Management**: Vehicles equipped with V2X (Figure 3.9-1) technology transmit real-time data on accidents, breakdowns, and road obstructions to the platform. Road authorities receive instant alerts and actionable insights to swiftly respond to incidents, minimizing traffic disruptions and improving emergency response times.
- **Work Zone Information**: Construction and maintenance activities often impact traffic flow and safety. Mobility 3.0 aggregates data on planned roadworks and construction zones, providing motorists with timely notifications and alternate routes to mitigate congestion and avoid delays.
- **Vehicle Sensor Data Integration**: The platform integrates sensor data from vehicles, including indicators such as fog lights, windshield wipers, and stability control systems. This comprehensive dataset enhances situational awareness for drivers and enables predictive analytics for traffic management authorities.
- **Special Vehicle Monitoring**: Vehicles with specialized functions, such as oversized loads or slow-moving vehicles, transmit their location and status in real time. This allows road managers to implement appropriate traffic control measures and ensure safe passage for all road users.

- **Dynamic Traffic Routing**: Leveraging advanced algorithms and machine learning techniques, Mobility 3.0 analyzes traffic patterns and recommends optimal routes for drivers based on current conditions and predictive models. This dynamic routing functionality minimizes travel time, reduces fuel consumption, and alleviates congestion on congested roadways.

Enhancing Safety, Efficiency, and User Experience

Mobility 3.0 prioritizes safety, efficiency, and user experience in every aspect of its design and functionality. By providing drivers with actionable insights and personalized recommendations, the platform empowers them to make informed decisions that enhance their safety and convenience on the road. Road authorities benefit from real-time visibility into traffic conditions, enabling proactive intervention and effective traffic management strategies. Additionally, vehicle manufacturers and service providers gain valuable insights into user behavior and traffic patterns, facilitating the development of innovative mobility solutions tailored to the needs of urban commuters.

Figure 3.9-1. Example of the framework of the use case 9.

3.9.4 Diagram of the use case

The diagram of the use case 9 is presented in Figure 3.9-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table 3.8-4., respectively.

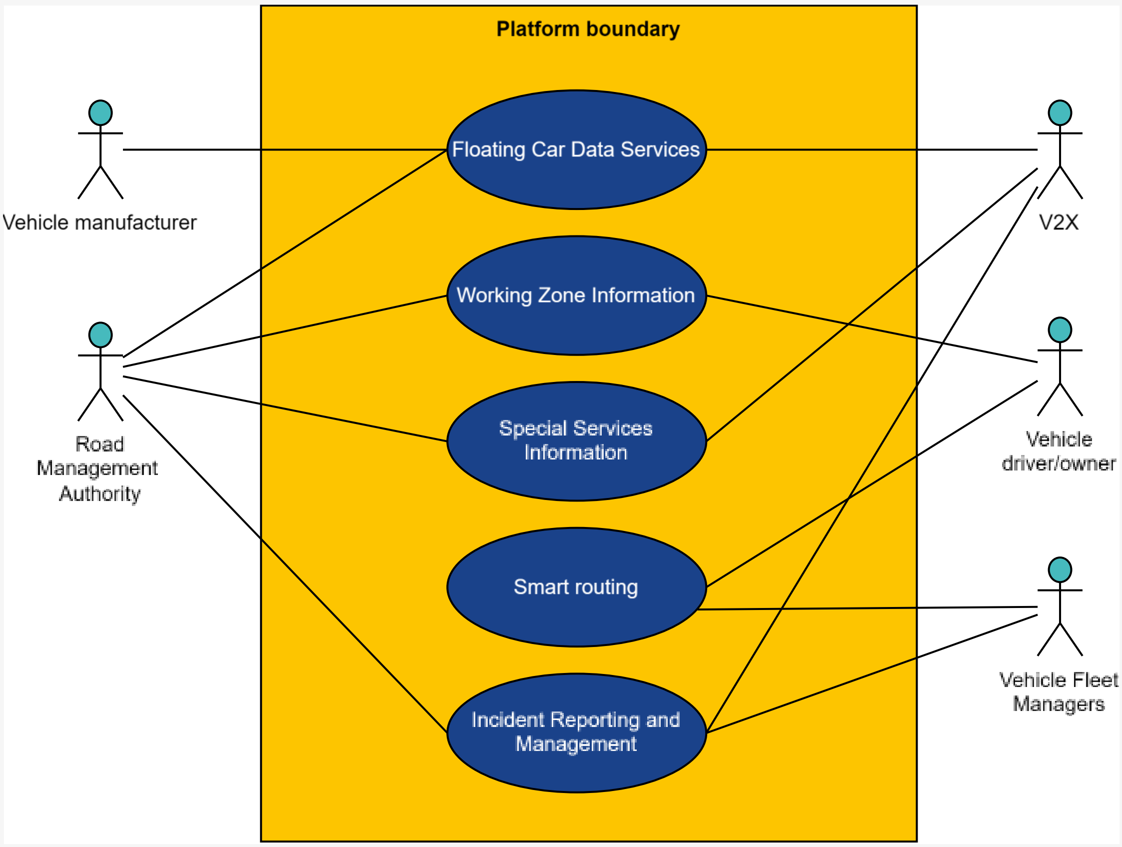

Figure 3.9-2. The diagram of the use case 9.

3.9.5 Actors of the use case

Table 3.9-3. Description of the actions of use case 9 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Road Management Authority	Role	Government agencies or departments responsible for planning, maintenance, and regulation of road networks operations within their jurisdiction.	Develop and implement traffic management policies, maintain road infrastructure, deploy traffic control systems, conduct safety assessments, and coordinate with other stakeholders.	No
Vehicle Manufacturers	Role	Companies involved in designing, developing, and selling vehicles.	Develop vehicle technology compatible with V2X communication, integrate sensors and communication systems into vehicles, ensure compliance with safety standards, and collaborate with other stakeholders to enhance traffic safety.	Car safety standards
Fleet Managers	Role	Organizations responsible for managing and operating fleets of vehicles, such as commercial transport	Monitor vehicle performance and maintenance, optimize route planning and scheduling, ensure compliance with regulations, and adopt V2X	No

Actor Name	Actor Type	Actor description	Actions	Standards
		companies or public transportation agencies.	technology for fleet management.	
Vehicle driver/owner	Role	Individuals operating motor vehicles for personal or professional purposes.	Access traffic information through mobile apps or in-vehicle systems, receive real-time alerts about road conditions, accidents, and hazards, adjust driving behavior based on recommendations, and participate in V2X communication by transmitting data from their vehicles.	No
V2X system	System	Data acquisition and monitoring system integrated on-board to transmit vehicle and driving information	It collects vehicle parameters related to all security and safety elements (e.g., lighting, speed, braking) and location for tracking purposes.	No

3.9.6 Scenarios

Table 3.9-4. Description of use case 9 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.09.S1	Accident Notification	A vehicle equipped with V2X technology detects a collision or accident.	The vehicle equipped with V2X technology detects an accident and automatically sends a notification to the centralized platform. The platform receives the notification and validates the incident, cross-referencing it with traffic management systems. Once confirmed, the platform disseminates real-time alerts to nearby drivers and relevant authorities, enabling prompt response and traffic management.	Vehicle equipped with V2X technology
BEG.09.S2	Notification of road intervention	A road maintenance crew sets up equipment for construction or repairs.	The local authority responsible for road maintenance reports ongoing road works to the centralized platform. The platform processes the information and generates real-time alerts, which are disseminated to drivers through navigation apps and in-vehicle systems. Drivers receive notifications about road closures, detours, and expected delays, allowing them to adjust their routes accordingly.	Road Management Authority
BEG.09.S3	Hazard Detection	Adverse weather conditions such as heavy rain, fog, or	Adverse weather conditions such as heavy rain, fog, or snow reduce visibility and road safety.	Road Management Authority or Traffic

		snow reduce visibility and road safety.	As alternative, V2X may inform about unexpected weather conditions based on fog lighting, wipers, brakes, speed…	Management Authority V2X (alternative in case of unexpected conditions)
BEG.9.S4	Traffic Congestion Management	High traffic volume leads to congestion on major roadways or intersections.	Traffic monitoring cameras detect congestion or slowdowns at specific locations and transmit the data to the centralized platform. The platform processes the information and calculates alternative routes to divert traffic away from congested areas. Real-time traffic updates and route recommendations are sent to drivers through navigation apps, helping them avoid delays and reduce travel time. As alternative, V2X may inform about unexpected traffic conditions based on speed, braking, among others.	Road Management Authority V2X (additional information)

3.9.7 Policy and digitalisation needs

Table 3.9-5. Description of use case 9 policy and digitalisation needs.

Policy needs	**Minimum Regulatory Framework** • Data Privacy and Security Regulations: Implement robust measures to ensure the protection of personal data collected from vehicles and users, adhering to GDPR and other relevant privacy laws. • Standardization of V2X Communication: Establish uniform standards for V2X communication protocols to facilitate interoperability among vehicles, infrastructure, and traffic management systems. • Liability and Insurance Regulations: Clarify liability issues related to incidents and accidents involving connected vehicles, defining the responsibilities of manufacturers, service providers, and road authorities. **Barriers** • Fragmented Regulatory Landscape: Inconsistent regulations across jurisdictions hinder the seamless deployment of Mobility 3.0, requiring harmonization efforts and cross-border cooperation. • Privacy Concerns: Despite the benefits of data-driven traffic management, privacy concerns may deter users from sharing their personal information, necessitating transparent data handling practices and user consent mechanisms. • Infrastructure Investment: The implementation of V2X infrastructure, including roadside units and communication networks, requires significant investment and collaboration between public and private stakeholders. **Legal and Social Factors**

	• Public Acceptance: Addressing public perceptions and attitudes towards connected vehicle technologies is crucial to fostering trust and acceptance among users, highlighting the benefits in terms of safety, efficiency, and convenience. • Ethical Considerations: Ethical dilemmas surrounding autonomous driving and algorithmic decision-making necessitate clear ethical guidelines and frameworks to ensure the responsible and ethical deployment of Mobility 3.0. **Regulatory Compliance** • Compliance with evolving regulatory requirements, including emission standards, vehicle safety regulations, and traffic laws, is essential to ensure the legal operation of connected vehicles and traffic management systems.
Digitalisation needs	**Data Standardization** • Heterogeneous Data Formats: Variability in data formats and structures from different vehicle manufacturers and IoT devices complicates data aggregation and analysis, requiring standardized data schemas and protocols for seamless interoperability. • Real-time Data Processing: The high volume and velocity of data generated by connected vehicles and roadside sensors pose challenges for real-time processing and analysis, necessitating scalable and efficient data processing frameworks. **Communication Infrastructure** • Network Connectivity: Inadequate network coverage and bandwidth limitations in certain regions may disrupt communication between vehicles and infrastructure components, requiring investment in robust communication infrastructure, including 5G networks. • Latency and Reliability: Latency and reliability issues in communication channels can impact the timeliness and accuracy of data exchange between vehicles and traffic management systems, necessitating low-latency communication technologies and redundant communication paths. **Interoperability Challenges** • Vendor Lock-in: Proprietary solutions and vendor-specific technologies may lead to vendor lock-in and interoperability challenges, inhibiting the integration of diverse hardware and software components from different suppliers. • Integration Complexity: Integrating heterogeneous systems, such as vehicle telematics platforms, traffic management systems, and smart city infrastructure, requires standardized interfaces and protocols to enable seamless interoperability and data exchange. **Cybersecurity Risks** • Vulnerability Exploitation: The interconnected nature of Mobility 3.0 systems increases the attack surface for cyber threats, including malware, ransomware, and denial-of-service attacks, necessitating robust cybersecurity measures to protect against potential breaches and intrusions. • Data Privacy Concerns: Data privacy breaches and unauthorized access to sensitive vehicle and user data pose significant risks to privacy and confidentiality, highlighting the need for encryption, access controls, and data anonymization techniques to safeguard personal information.

3.10 Use case 10: Floating Car Data for dynamic insurance services

3.10.1 Use case identification

Table 3.10-1. Scope and objectives of use case 10.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.10	Floating Car Data for dynamic insurance services	☒ Local ☒ Regional ☒ National ☒ Cross-border ☒ Outermost	☒ Customer ☒ DER ☒ Distribution ☒ Transmission ☒ Generation	☒ Customer information ☒ Vehicle ☒ Energy station ☒ Infrastructure ☒ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.10.2 The scope and objectives of the use case

Table 3.10-2. Scope and objectives of use case 10.

Scope and Objectives of the Use Case	
Scope	The use case aims to develop an ODP specifically designed for - operating within the European market, based on Vehicle-to-Everything (V2X) technology. This platform will enable vehicles to transmit real-time data about drivers' behavior and environmental conditions to create detailed driver profiles. Insurance companies can use these profiles to offer personalized insurance policies and dynamic tariffs based on driving patterns and risk factors. Vehicle manufacturers will be integral to this system by embedding V2X technology in their vehicles, ensuring seamless data transmission across borders within Europe. The platform will support the monitoring of driving habits, such as route regularity, driving in high-risk areas, and adherence to traffic regulations, allowing for continuous assessment and adjustment of insurance tariff conditions. This approach aims to enhance road safety, provide fairer insurance pricing, and promote responsible driving behavior across the continent.
Objectives	• Utilize real-time data from V2X-enabled vehicles to monitor driving behaviors and environmental conditions, promoting safer driving practices and reducing accidents. • Enable insurance companies to create tailored insurance products based on individual driving profiles, providing more accurate and fair pricing for policyholders. • Implement a system of dynamic insurance tariffs that adjust based on driving patterns, route choices, and risk factors, incentivizing safer and more efficient driving habits. • Ensure seamless data transmission and usage across different countries in Europe, allowing insurance policies to adapt to driving behaviors and risks encountered in various regions. • Partner with vehicle manufacturers to embed V2X technology in new vehicles, facilitating the widespread adoption and effectiveness of the platform. • Provide insurance companies with the tools to expand their offerings and reach new customers through innovative, data-driven insurance products.
Reference country(ies)	Spain and Portugal
Related Business Case	Traffic management, Dynamic pricing, Roaming services

Possible Stakeholders	Insurance companies, Vehicle manufacturers, Vehicle owners

3.10.3 Narrative of the use case

The digital age has revolutionized various industries, and the insurance sector is no exception. Traditional insurance models often fall short in providing personalized, dynamic solutions that align with individual user behaviors and needs. With the rise of connected vehicle technologies, particularly Vehicle-to-Everything (V2X) systems, there is a significant opportunity to enhance the user experience in insurance by leveraging real-time driving data. This approach can cover all aspects related to driving, offering tailored insurance products that reflect actual usage patterns and driving conditions.

The ODP for insurances is designed to harness the power of V2X technology to collect and analyze data from vehicles, enabling insurance companies to develop personalized insurance policies. This data-driven approach allows for the creation of dynamic tariffs that adjust based on real-time driving behaviors, road conditions, and geographic factors. By partnering with vehicle manufacturers, the platform ensures comprehensive data integration and seamless functionality across Europe.

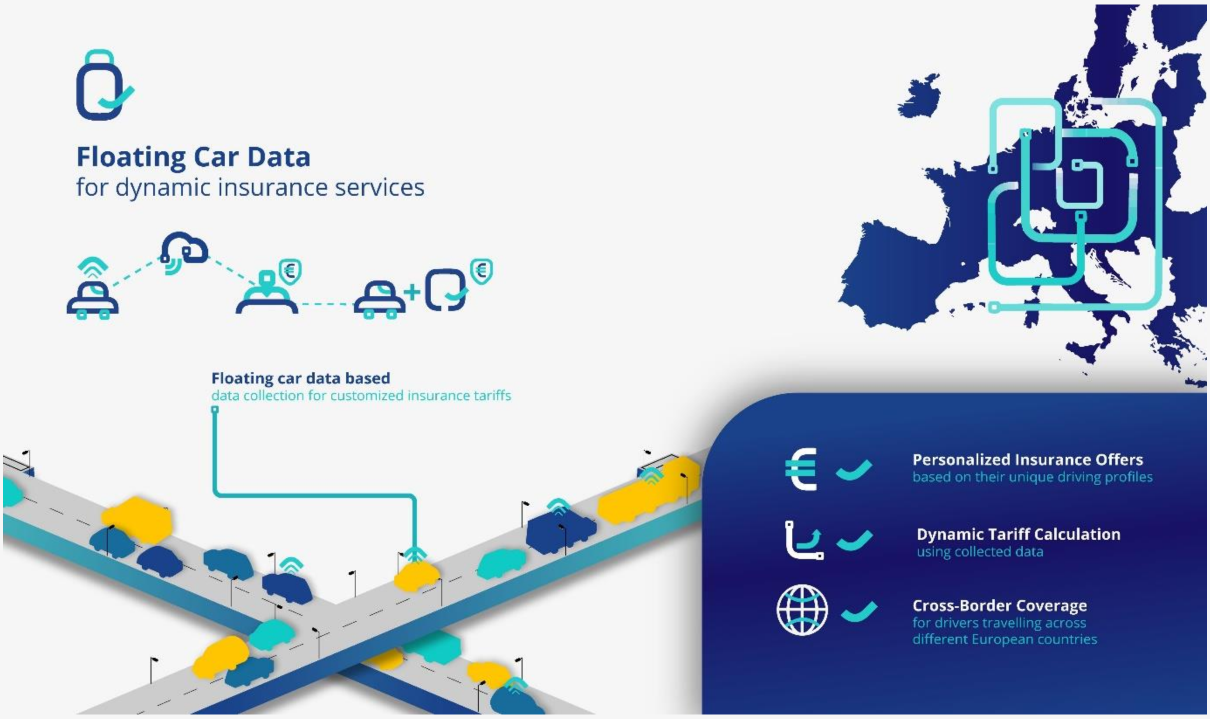

Figure 3.10-1. The framework of the use case 10.

The Insurance ODP offers a range of services designed to enhance both user experience and operational efficiency for insurance companies. Key services include:

- **Real-Time Data Collection**: Gather real-time data on driving behaviors, vehicle performance, and road conditions through V2X-enabled vehicles.
- **Dynamic Tariff Calculation**: Use collected data to calculate insurance tariffs that adjust based on driving habits, road types, and usage patterns.

- **Personalized Insurance Offers**: Provide tailored insurance products that meet the specific needs of individual drivers, based on their unique driving profiles.
- **Cross-Border Coverage**: Ensure continuous insurance coverage and data tracking for drivers traveling across different European countries.
- **Risk Assessment and Management**: Analyze driving data to assess risk levels accurately and offer appropriate insurance products.
- **Real-Time Feedback and Alerts**: Real-time feedback to drivers regarding their driving behaviors, encouraging safer practices and immediate corrective actions.

3.10.4 Diagram of the use case

The diagram of the use case 10 is presented in Figure 3.10-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table 3.8-4., respectively.

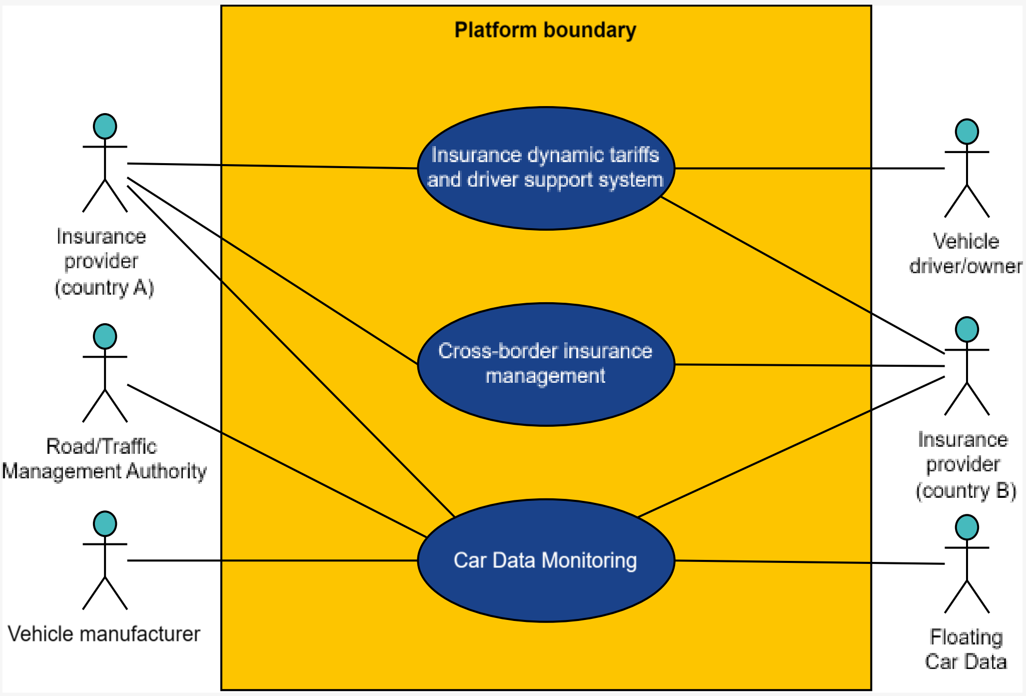

Figure 3.10-2. The diagram of the use case 10.

3.10.5 Actors of the use case

Table 3.10-3. Description of the actions of use case 10 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Floating Car Data	System	Embedded vehicle monitoring system connected on GPS and Internet platform	The floating car data register and broadcast the vehicle status, location and driving conditions to the system operator.	GPS and Internet protocols
Vehicle Owner/Driver	Role	The owner or driver of a vehicle equipped with V2X technology	Supplies driving behavior data to the system (e.g., speed, braking patterns, route information). Receives personalized insurance offers and driving feedback from the system.	No

			Uses in-vehicle or mobile application interfaces to interact with the system.	
Vehicle Manufacturer	Role	Company that develops vehicles equipped with V2X systems capable of gathering and transmitting data.	Supplies vehicle data (e.g., diagnostic information, sensor data) to the system. Ensures V2X hardware and software compatibility. Updates vehicle systems to maintain interoperability with the ODP. Collect data about driving conditions to improve the design of vehicles (performance, safety…)	No
Insurance Company (Country A/B)	Role	The entity that provides insurance services to vehicle owners/drivers and uses V2X data for risk assessment and dynamic tariffs.	Receives and analyzes driving behavior and vehicle data to calculate personalized insurance tariffs. Supplies insurance offers, policy updates, and driving safety recommendations to vehicle owners/drivers. Monitors driving patterns and incidents in real-time to adjust risk profiles and tariffs dynamically.	No
Road/Traffic Management Authority	Role	Public authorities responsible for managing traffic flow and road safety.	Supplies real-time traffic and road condition data to the system. Receives aggregated vehicle data to enhance traffic management strategies and maintenance interventions. Coordinates with insurance companies and vehicle manufacturers to improve overall road safety.	No

3.10.6 Scenarios

Table 3.10-4. Description of use case 10 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.10.S1	Dynamic Insurance Tariffs Adjustment	A vehicle owner starts their car and begins driving, transmitting V2X data to the Insurance 3.0 platform.	The Vehicle Owner/Driver begins driving, and the vehicle's V2X system starts transmitting real-time data (speed, location, driving behavior) to the ODP. The Insurance Company receives this data and analyzes it to assess the driver's risk profile. Based on the analysis, the Insurance Company dynamically adjusts the insurance tariff for the trip and sends notifications to the Vehicle Owner/Driver about the new rate. If the driving behavior is consistently safe, the Insurance Company may offer discounts or rewards to the Vehicle Owner/Driver. The Vehicle Owner/Driver can view the updated premium and driving insights through their in-vehicle system or mobile app.	Vehicle Owner/Driver
BEG.10.S2	Cross-Border Driving Assessment	A vehicle owner drives across national borders within	The Vehicle Owner/Driver crosses a national border, and the vehicle's V2X system continues to transmit driving data to the ODP. The Insurance Company receives the cross-border	Vehicle Owner/Driver

		Europe, entering a different country's road network.	driving data and adjusts the risk assessment based on the new driving environment. If the new country's roads present higher risks (e.g., mountainous terrain), the Insurance Company updates the insurance premium accordingly. The Vehicle Owner/Driver receives a notification about the premium adjustment and any specific driving advice for the new country. The Vehicle Owner/Driver can review the cross-border driving data and premium changes through their in-vehicle system or mobile app.	
BEG.10.S3	Accident Notification and Claim Processing	A vehicle equipped with V2X technology is involved in an accident.	The Vehicle Owner/Driver is involved in an accident, and the vehicle's V2X system automatically detects the incident and sends an alert to the ODP. The Insurance Company receives the accident notification, including the location, severity, and other relevant data. The Insurance Company immediately contacts the Vehicle Owner/Driver to ensure their safety and provide assistance. The Insurance Company initiates the claim process by gathering additional details and dispatching a claims adjuster if necessary. The Vehicle Owner/Driver submits any required information through their mobile app or in-vehicle system. The Insurance Company processes the claim and updates the Vehicle Owner/Driver on the status and next steps.	Vehicle Owner/Driver

3.10.7 Policy and digitalisation needs

Table 3.10-5. Description of use case 10 policy and digitalisation needs.

Policy needs	**Minimum Regulatory Framework** - Ensuring compliance with GDPR to protect user data privacy and secure consent for data collection and processing. Furthermore, compliance with regulations concerning the confidentiality of communications and the lawful collection of data. - Establishing unified standards for Vehicle-to-Everything (V2X) communications to ensure interoperability between different manufacturers and systems. Alignment with existing traffic management and road safety regulations to integrate V2X systems seamlessly. - Regulatory frameworks guiding the fair assessment of risk and dynamic pricing models for insurance products. Harmonized regulations to ensure seamless insurance coverage and data integration across different European countries. **Barriers** - User Consent and Anonymity: Ensuring that users are fully informed and provide explicit consent for data collection, addressing concerns about anonymity and misuse of personal data. Implementing robust security measures to protect sensitive user data from breaches and cyber-attacks. - Standardization of V2X Systems: The lack of standardized V2X communication protocols can hinder the seamless integration of data from different vehicle manufacturers and systems. The difficulty in

	integrating the new platform with existing infrastructure and traffic management systems must be considered. • Cross-Border Regulations: Variations in insurance and data privacy regulations across European countries can complicate the implementation of a unified platform. **Legal and social factors** • Liability and Accountability: Defining clear liability and accountability frameworks for accidents and incidents involving V2X-enabled vehicles and data usage. • Public Awareness and Acceptance: Increasing public awareness and acceptance of V2X technology and data-driven insurance models, addressing potential resistance due to privacy concerns.
Digitalisation needs	**Data Integration and Management** • Data Volume and Variety: Managing the large volume and variety of data generated by V2X systems, including vehicle diagnostics, driving behavior, and environmental conditions. • Real-Time Processing: Ensuring the capability to process and analyze data in real-time to provide timely and accurate information for dynamic insurance pricing and risk assessment. **Connectivity and Network Infrastructure** • Network Coverage: Ensuring comprehensive network coverage, especially in rural and remote areas, to support continuous V2X communication. • Latency and Bandwidth: Addressing issues related to network latency and bandwidth to enable seamless data transmission and real-time updates. **Security and Privacy** • Cybersecurity Threats: Implementing advanced cybersecurity measures to protect the V2X communication network and user data from cyber-attacks. • Data Encryption: Ensuring end-to-end encryption of data to maintain confidentiality and integrity during transmission and storage. **Cross-Border Data Exchange** • Harmonized Standards: Establishing harmonized standards for data exchange across different countries to ensure seamless cross-border interoperability. • Regulatory Alignment: Aligning regulations related to data privacy, security, and insurance across different jurisdictions to facilitate cross-border operations. **Multi-Stakeholder Collaboration** • Stakeholder Coordination: Coordinating among various stakeholders, including vehicle manufacturers, insurance companies, regulators, and service providers, to ensure smooth collaboration and data sharing. • Data Sharing Agreements: Developing clear data sharing agreements and frameworks to facilitate collaboration while protecting proprietary and sensitive information.

3.11 Use case 11: Digital permits for drone-based inspections in linear infrastructures

3.11.1 Use case identification

Table 3.11-1. Identification of use case 11.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.11	Digital permits for drone-based inspections in linear infrastructures	☐ Local ☐ Regional ☐ National ☒ Cross-border ☐ Outermost	☐ Customer ☐ DER ☐ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☐ Vehicle ☐ Energy station ☒ Infrastructure ☒ Traffic and logistic	☒ Edge ☐ Fog ☒ Cloud	☐ Component ☐ Communication ☒ Information ☒ Function ☒ Business

3.11.2 The scope and objectives of the use case

Table 3.11-2. Scope and objectives of use case.

Scope and Objectives of the Use Case	
Scope	Drone inspections have demonstrated to be a very efficient approach to support maintenance operations, acquiring information quickly and in a safety manner, that otherwise cannot be obtained with traditional procedure or visual inspections from a distance. However, drone operation is regulated at multiple levels (European, National and Regional) and depends on many authorization bodies (air traffic control provider, traffic directorate, environmental agencies…) that takes months or even a year to validate a flight application. This dependency between different validation authorities or agents means that this method remains exceptional for a mature and established technology. A digital platform based on blockchain to manage digital permits for drone-based maintenance applications can reduce the bureaucracy effort and time, making this type of inspections accessible, manageable and safer, validating in a one platform all the legal and regulatory conditions, especially in cross-border contexts.
Objective	• Reduction of the time needed to obtain a flight permit to perform infrastructure inspections with drones. • Reducing the risk of human error in the drone flight validation process while ensuring compliance with all applicable regulations. • Improved maintenance of linear infrastructure under cross-border conditions with more frequent and accurate inspections. • Reduction of traffic disruptions or undesired effects during infrastructure inspections, ensuring road safety. • Improve coordination between air safety agencies and public authorities to promote the use of drones to improve road safety, infrastructure maintenance and environmental protection.
Reference country(ies)	Spain, Portugal, France
Related Business Case	Maintenance Operations, Drone Operations in cross-border conditions

Possible stakeholders	Maintenance managers, linear infrastructure authorities, air traffic controllers, drone operators

3.11.3 Narrative of the use case

Infrastructure managers recognise that drone inspections provide valuable information to implement accurate maintenance plans, which otherwise could not be done with the same scope and efficiency. However, drone inspections require lengthy bureaucratic procedures that slow down the process and make it impossible to schedule such inspections on a regular basis, which does not allow for a thorough follow-up of possible damage and does not fully integrate into the maintenance inspection portfolio of linear infrastructures. The procedure involves the permission of different authorities at local, regional, national and cross-border level such as infrastructure management bodies, maintenance, traffic, air control... In addition, the inspection requires suitable weather conditions (e.g. low wind speed) which also limits the time window for carrying out the inspection, which may lead to revocation of the permit.

Digital permits between air traffic control provider, authority bodies and other stakeholders may minimize the waiting period, making more suitable the integration of this innovative inspections into the usual maintenance procedures of linear infrastructures.

Figure 3.11-1. The framework of the use case 11.

An ODP with blockchain can connect the stakeholders related to linear infrastructure inspections quickly and securely, in a way that establishes the governance model and permits according to the countries involved. The infrastructure manager (country A) requests the inspection (work order) based on their support decision system and the maintenance management system of the entire value chain. Authorities sharing the ownership or legal responsibilities about the linear assets receive the request (scope, duration and legal compliance) and generate the validation form based on the inspection details. If some stakeholder requests clarifications or additional compliance, this event is communicated automatically to all the stakeholders to minimize the number of iterations. In case all stakeholders agree and validate the request, the inspection date and duration are confirmed and can be executed.

3.11.4 Diagram of the use case

The diagram of the use case 11 is presented in Figure 3.11-2 and Actors' actions and scenarios' descriptions are presented in Table 3.11-3 and Table 3.11-4, respectively.

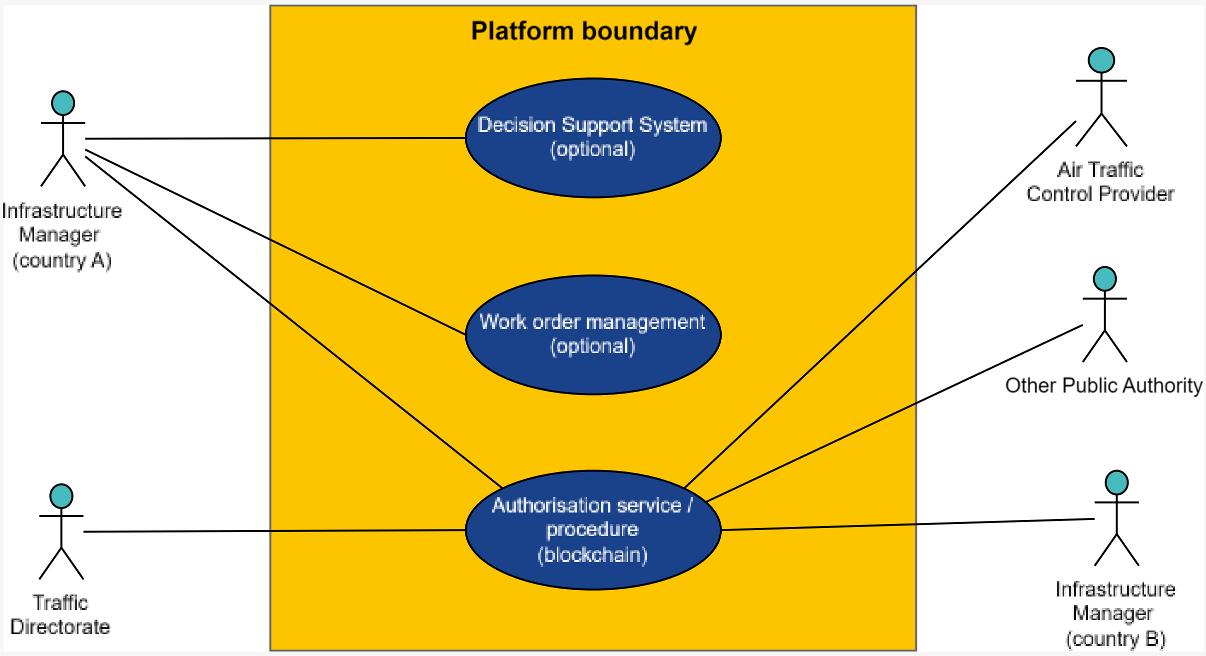

Figure 3.11-2. The diagram of the use case 11.

3.11.5 Actors of the use case

Table 3.11-3. Description of the actions of use case 11 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Infrastructure manager (country A)	Role	National authority or the company responsible for maintaining cross-border linear infrastructure.	It makes the decision to carry out a drone-based inspection of a cross-border infrastructure. It generates the work order for a work operator. It generates the request with the drone operator and work order details (location, duration and specifications) It may receive requests to clarify some details or the	IEEE 3205-2023 IEEE 3801-2022

			final validation to carry out the inspection.	
Traffic Directorate	Role	National Authority responsible for road mobility	It receives requests from the infrastructure manager. It assesses the traffic impact of the inspection (if appropriate) and can generate an additional query for further details. It validates the permission and prepares the operation to support the intervention.	IEEE 3205-2023 IEEE 3801-2022
Air Traffic Control Provider	Role	National Authority to regulate flights	It receives requests from the infrastructure manager. It evaluates the legal conditions of the request (licenses, restrictions…) It may generate additional queries for further details. It validates the intervention date and duration.	IEEE 3205-2023 IEEE 3801-2022
Other public authority	Role	Any other public authority responsible for getting permissions	It receives maintenance intervention request. It evaluates the compliances with National/Regional regulations. It may generate additional queries for clarification. It validates the intervention.	IEEE 3205-2023 IEEE 3801-2022
Infrastructure manager (country B)	Role	National authority or the company responsible for maintaining the linear infrastructure beyond the cross-border	It replicates the request of Country A for National compliance of country B.	IEEE 3205-2023 IEEE 3801-2022

Referenced standards:

- IEEE 3205-2023 IEEE Standard for Blockchain Interoperability Data Authentication and Communication Protocol
- IEEE 3801-2022 EEE Standard for Blockchain-based Electronic Contracts

3.11.6 Scenarios

Table 3.11-4. Description of use case 11 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor

BEG.11 S1	Application request	The user generates a request for flight authorization.	The application contains the flight details (drone, drone operator license, location, duration, estimated date…)	The infrastructure manager (country A)
BEG.11 S2	Application validation	All the actors validate the flight application	All actors receive the application details and validate their specific legal and regulatory conditions	Traffic Directorate Air Traffic Control Provider Other public authority Infrastructure manager (country B)
BEG.11.S3	Application rejection	Some actors reject the application because the action is prohibited	Some actor detects that the application does not fulfil with legal or regulatory conditions	Traffic Directorate Air Traffic Control Provider Other public authority Infrastructure manager (country B)
BEG.11.S4	Modification request	Some actors request additional information due to missing or unclear information or for non-compliance	Some actor detects that some information is missing or unclear or the application does not fulfil with legal or regulatory conditions	Traffic Directorate Air Traffic Control Provider Other public authority Infrastructure manager (country B)

3.11.7 Policy and digitalisation needs

Table 3.11-5. Description of use case 11 policy and digitalisation needs.

Policy needs	This use case has been generated as need of main Spanish cross-borders. Therefore, current regulations between Spain, Portugal and France are described as follows: **Spain** • Regional authorities may issue their own drone regulations. • Drones must always be flown within the visual line of sight. During first-person view (FPV) flights a second visual observer must monitor the drone with the eye and be in direct contact with the pilot. • Drone pilots must maintain a distance of at least 8 km to airports in uncontrolled airspace, or 15 km on approved beyond visual line of sight (BVLOS) flights. • Drone pilots must maintain 150 m from buildings, and 50 m or more from people not involved in the flight. • For flights in national parks, you need permission from the AESA (Spanish Air Security Agency). The use of drones in no-fly zones must be approved by the Spanish Ministry of Defense (processing time is approximately one week). • AESA has established procedures to obtain official flight permits. • EANAIRE has a website (app) to check the restrictions applied in a specific area like protected natural space, airspace, safety area, etc. • As exception, the Royal Decree 1036 establishes in Article 44 that in the event of situations involving serious risks, catastrophes, or public calamities, and if requested to do so by the public authority responsible for managing such situations, licensed Remotely Piloted Aircraft System (RPAS) operators may conduct flights that do not comply with the conditions and limitations of this Royal Decree. In the event of an RPAS flight being conducted in a flight information zone or within protection

	areas covered by Article 23 ter.3, letter b) of Royal Decree 552/2014 of 27 June, the pilot must coordinate with the corresponding air navigation service provider beforehand. **Portugal** • Drones may not be used to capture images or video without permission from the National Aeronautical Authority (ANAC) • Drone pilots must always maintain a visual line of sight with their drones while flying. • Drones are prohibited in open air concentrations, in the specific operational protection areas of airports and aerodromes, and in facilities where sovereign bodies, embassies and consular representations, military installations, security services, police and civil protection missions, prisons and educational centers of the General Rehabilitation and Prison Services Directorate. **France** • The drone operator must be registered and needs proof of competency. • The drone must always be in a visual line of sight (VLOS). • The drone is flown at no more than 120 m above ground level. • The drone must not carry any dangerous goods or drop any material. **Barriers and limitations** • Although National regulations derive from the European Union Aviation Safety Agency (EASA), every country has their own restrictions (e.g. distances, areas, number of authorization entities…) • There is not a cross-border (digital) procedure to fly a drone. The flight must fulfil both restrictions at the same time, taking months and up to one year to obtain the permit. In Spain, specific rules may apply at regional level, increasing the steps and time to get the permission.
Digitalisation needs	• Standardization of the validation procedure and governance models for drone-based inspections (e.g. EASA) • Digital platform (or data space) connecting National and Transnational authorities to validate cross-border drone-based operations, and existing flight monitoring systems (e.g. ENAIRE in Spain). • Specific blockchain standards to validate digital permits for public administration.

3.12 Use case 12: Smart Ports Operations

3.12.1 Use case identification

Table 3.12-1. Identification of use case 12.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.12	Smart Port Operations	☒ Local ☒ Regional ☐ National ☒ Cross-border ☒ Outermost	☐ Customer ☐ DER ☐ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☒ Vehicle ☐ Energy station ☒ Infrastructure ☒ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☐ Information ☒ Function ☒ Business

3.12.2 The scope and objectives of the use case

Table 3.12-2. Scope and objectives of use case 12.

Scope and Objectives of the Use Case	
Scope	The Smart Port Operations Use Case aims to revolutionize port management by integrating advanced monitoring technologies and digital platforms. Utilizing AI cameras and drone systems, the use case focuses on real-time monitoring of port operations, including docks, cranes, and ships, and volumetric measurement of stockpiles. Data from these technologies will be integrated into the Port's FIWARE digital platform, as adopted by the CEF. This integration sets the boundary for the project, emphasizing improved operational efficiency, safety, and sustainability in port activities
Objective	The main objectives of the use case are as follows: • Deploy AI-driven cameras and drone systems to monitor port operations in real-time, ensuring efficient management, improved safety, and security of docks, cranes, ships, and stockpiles. • Ensure seamless integration of data from AI cameras and drones into the port's FIWARE digital platform, enabling comprehensive data analysis, visualization, and informed decision-making. • Use accurate real-time data to optimize resource allocation, scheduling, and inventory management, promoting sustainable practices and reducing environmental impact. • Establish a scalable and replicable model for digital transformation in ports, fostering collaboration among port authorities, technology providers, and stakeholders for continuous improvement of smart port solutions. • Implement advanced technologies to streamline port operations, enhance overall efficiency, and create a framework that can be scaled and adapted to other ports globally.
Reference country(ies)	Spain
Related Business Case	Port management
Possible Stakeholders	Port operators and managers, Shipping companies,

3.12.3 Narrative of the use case

The Smart Port Operations Use Case is designed to revolutionize port management through the integration of advanced technologies and digital platforms. At its core, the initiative aims to enhance monitoring, streamline operations, and elevate safety standards within port environments.

Key components of the use case include the deployment of AI cameras strategically positioned throughout the port. These cameras continuously monitor vessel movements, cargo handling activities, and port infrastructure, providing real-time insights to optimize operations.

In addition to AI cameras, drones equipped with advanced sensors and imaging capabilities are deployed for daily reconnaissance missions over the port. These unmanned aerial vehicles capture detailed imagery of stockpiles and cargo storage areas, enabling accurate volumetric measurements and resource allocation optimization.

The data collected by AI cameras and drones is centralized and processed within the Port's FIWARE digital platform. FIWARE, a standardized and interoperable platform adopted by the CEF, serves as the central hub for data analysis and decision-making. It enables real-time monitoring, analysis, and collaboration among port stakeholders, facilitating swift responses to emerging situations and enhancing overall operational efficiency.

Through the Smart Port Operations Use Case, ports can achieve improved efficiency, safety, and sustainability, ensuring smoother operations and contributing to global trade and commerce.

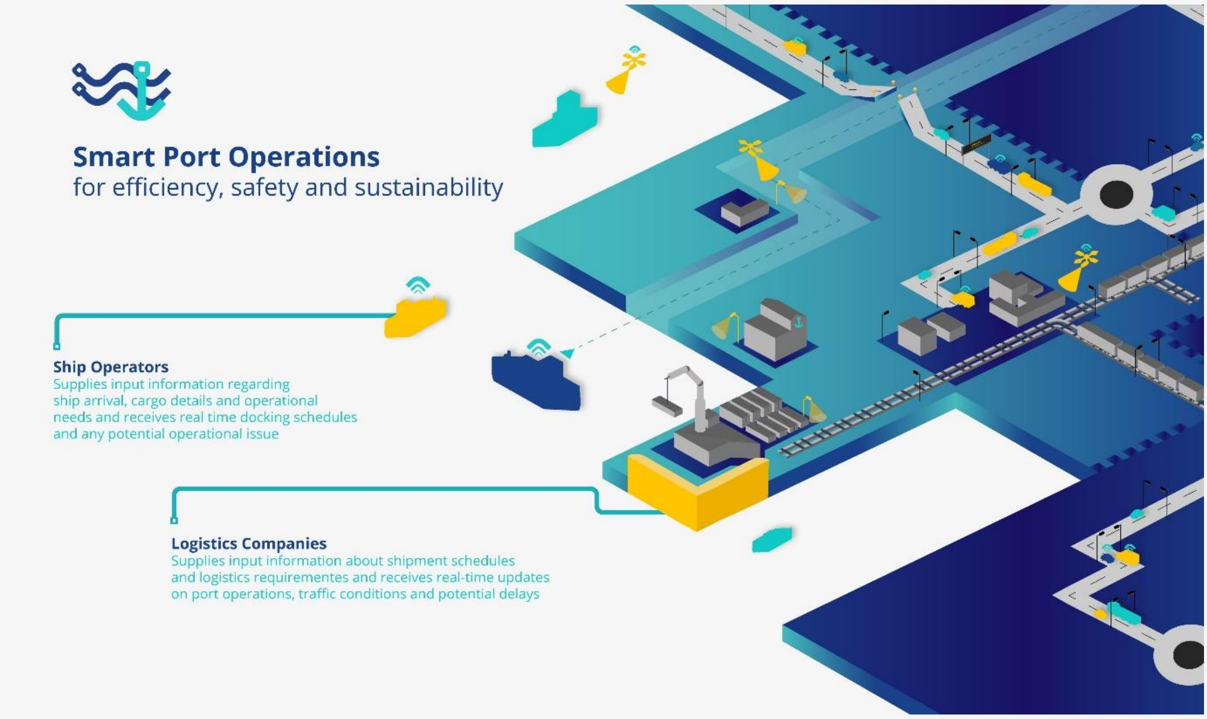

Figure 3.12-1. The framework of the use case 12.

3.12.4 Diagram of the use case

The diagram of the use case 12 is presented in Figure 3.12-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table 3.8-4., respectively.

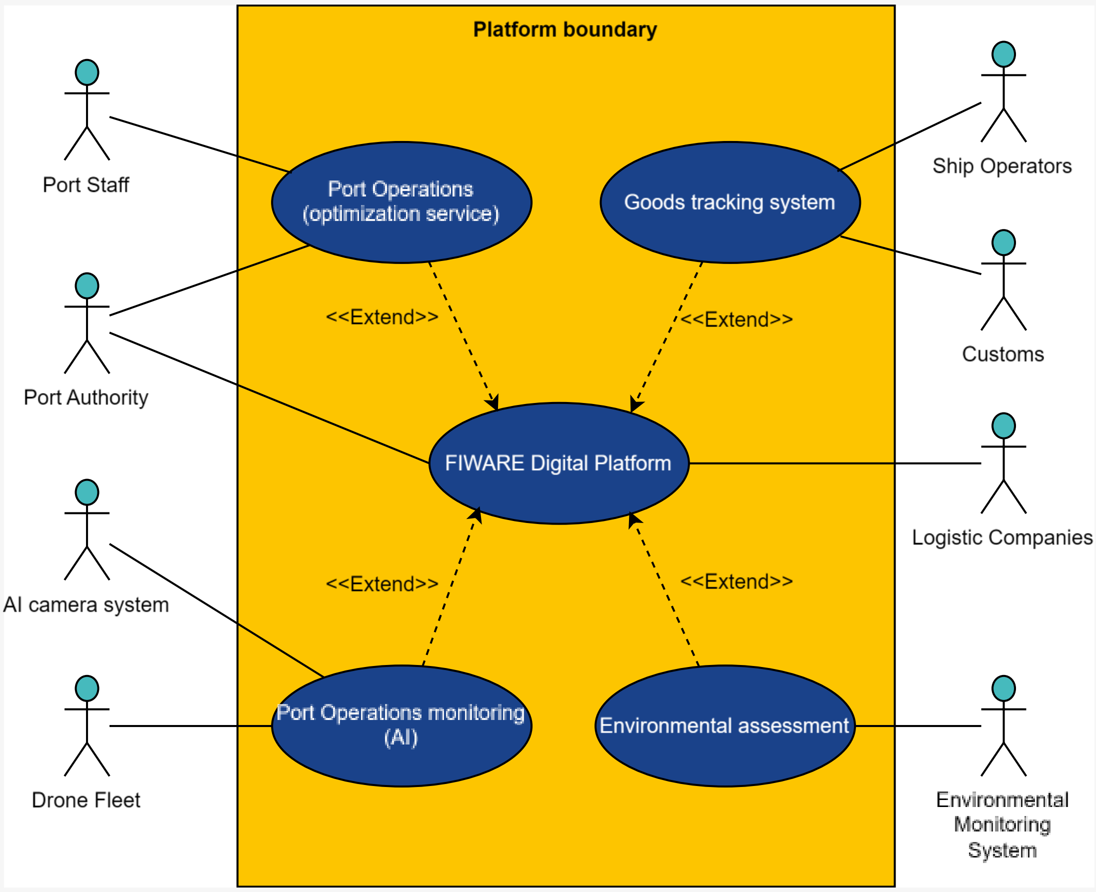

Figure 3.12-2. The diagram of the use case 12.

3.12.5 Actors of the use case

Table 3.12-3. Description of the actions of use case 12 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Port Authority	Role	The governing body responsible for the overall management, regulation, and administration of the port.	-Supplies input information about port regulations, schedules, and safety protocols. -Receives real-time operational data from AI cameras and drones. -Both supplies and receives information to ensure smooth and efficient port operations, overseeing all activities.	No
AI Camera System	System	An intelligent camera network installed throughout the port to monitor operations and detect anomalies.	-Supplies real-time video and analytical data to the central digital platform. -Receives configuration updates and operational commands from the digital platform.	ISO 27001

Drone Fleet	System	A fleet of drones programmed to conduct volumetric measurements and surveillance of the port.	-Supplies aerial data, including volumetric measurements of stockpiles, to the central platform. -Receives flight plans, operational commands, and data processing instructions from the digital platform.	EASA (EU) 2019/947.
Logistics Companies	Role	Companies responsible for transporting goods to and from the port, managing supply chains, and coordinating with port authorities.	-Supplies input information about shipment schedules and logistics requirements. -Receives real-time updates on port operations, traffic conditions, and potential delays.	No
Ship Operators	Role	Entities responsible for managing ships docking at the port, including cargo handling and scheduling.	-Supplies input information regarding ship arrival and departure times, cargo details, and operational needs. -Receives real-time updates on docking schedules, available resources, and any potential operational issues.	No
Customs Authorities		Government officials responsible for regulating and inspecting goods entering and leaving the port to ensure compliance with national laws.	-Supplies input information about customs regulations and requirements. -Receives real-time data on incoming and outgoing shipments to facilitate inspections and compliance checks.	National Regulations
Environmental Monitoring Systems	System	Systems installed to monitor environmental conditions, such as air and water quality, within the port.	-Supplies real-time environmental data to the digital platform. -Receives alerts and commands for data collection and reporting from the digital platform.	ISO 14001
Port Staff	Role	Employees working within the port, including dockworkers, crane operators, and administrative staff.	-Supplies input information on operational status, equipment conditions, and work schedules. -Receives real-time updates on operational tasks, safety protocols, and workflow changes.	No

3.12.6 Scenarios

Table 3.12-4. Description of use case 12 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.12.S1	Real-Time Monitoring of Port Operation	Detection of unusual activity or operational anomalies by AI cameras.	AI cameras installed throughout the port continuously monitor activities such as docking, loading, and unloading of ships. If the AI system detects unusual activity, such as unauthorized access to restricted areas or operational inefficiencies, it immediately sends an alert to the Port	AI Camera System

			Authority through the FIWARE digital platform. The Port Authority reviews the alert, verifies the issue using the camera feed, and coordinates with the Security Personnel to address the anomaly. The security team takes necessary actions to resolve the issue and updates the Port Authority. The incident is logged in the digital platform for future reference and analysis.	
BEG.12.S2	Volumetric Measurement of Stockpiles	Scheduled drone flight for daily volumetric measurement.	At a scheduled time, drones programmed to measure stockpile volumes take off and follow pre-defined routes around the port. They capture detailed aerial images and use software to calculate the volume of materials stored in the port. This data is transmitted to the FIWARE digital platform, where it is processed and analyzed. The Port Authority receives a detailed report on stockpile volumes, which is also accessible to Logistics Companies and Environmental Monitoring Systems for inventory management and environmental impact assessments. Any discrepancies or unusual findings are flagged for further investigation.	Drone Fleet
BEG.12.S3	Coordination of Ship Docking	Arrival notification of an incoming ship.	When a ship is approaching the port, the Ship Operators notify the Port Authority of its estimated time of arrival and docking requirements. The Port Authority uses real-time data from AI cameras and the digital platform to assess the availability of docking spaces and allocate a suitable dock for the incoming ship. The information is relayed back to the Ship Operators and the port workforce. Dockworkers prepare the allocated dock, and the ship docks smoothly. The process is monitored in real-time to ensure efficiency and safety. Any issues are immediately addressed by coordinating with the relevant actors.	Ship Operators
BEG.12.S4	Environmental Monitoring and Response	Detection of environmental threshold breaches by monitoring systems.	Environmental Monitoring Systems continuously collect data on air and water quality within the port. If any environmental parameter breaches the pre-set safety thresholds, the system sends an alert to the FIWARE digital platform. The Port Authority receives the alert and coordinates with Environmental Monitoring Systems and the port workforce to investigate the source of the pollution. Corrective actions are taken, such as adjusting operations or	Environmental Monitoring Systems

			implementing mitigation measures. The response and actions taken are logged in the digital platform for regulatory reporting and future reference.	

3.12.7 Policy and digitalisation needs

Table 3.12-5. Description of use case 12 policy and digitalisation needs.

Policy needs	**Minimum regulatory requirements** • AI camera deployments and drone inspection involves collectiong and processing massive amounts of data, including potentially sensitive information. In this regard, the compliance with GDPR is essential. • Aviation and Drone Operation Laws: The use of drones for monitoring and volumetric measurements requires adherence to aviation regulations governing drone operations. This includes obtaining necessary permits, ensuring drones are operated by certified pilots, and complying with flight restrictions in and around port areas. • Port operations are subject to environmental regulations aimed at minimizing pollution and protecting marine ecosystems. This includes adhering to noise pollution standards and avoiding interference with wildlife. • Ports must ensure that their infrastructure can support the deployment of advanced technologies. This includes having adequate network bandwidth, reliable power supply, and robust IT infrastructure. **Legal and Social Factors** • The introduction of advanced technologies may necessitate reskilling and upskilling of the port workforce. Ensuring that workers are adequately trained to operate and interact with new technologies is essential for implementation • Determining legal liability in the event of technology failures or incidents involving AI cameras and drones requires clear legal frameworks.
Digitalisation needs	**Interoperability** • The FIWARE digital platform serves as a central hub for data integration. However, other ports may use different digital platforms. Ensuring compatibility and interoperability between FIWARE and other platforms • Ensuring seamless data integration between AI cameras, drones, and existing port management systems is crucial. This requires standardized data formats and protocols. **Technical infrastructure** • Reliable and high-speed network connectivity is key for the real-time transmission of data from AI cameras and drones to the digital platform. • Ports must have adequate data storage and processing capabilities to handle the amount of information. **Cybersecurity** • Implementing robust cybersecurity measures, such as encryption, secure access controls, and regular security audits is necessary. **Scalabilty**

	• Implementing a modular architecture allows for incremental upgrades and integration of new technologies • Flexible AI and drone systems that can be easily expanded or adapted to meet the specific needs of each port are needed.

3.13 Use case 13: Carboon footprint in logistic operations

3.13.1 Use case identification

Table 3.13-1. Identification of use case 13.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.13	Carbon footprint of ports supply chain	☐ Local ☐ Regional ☐ National ☒ Cross-border ☒ Outermost	☐ Customer ☐ DER ☐ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☐ Vehicle ☐ Energy station ☐ Infrastructure ☒ Traffic and logistic	☒ Edge ☐ Fog ☒ Cloud	☐ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.13.2 The scope and objectives of the use case

Table 3.13-2. Scope and objectives of 13 use case.

Scope and Objectives of the Use Case	
Scope	Provide society with reliable, standardize and verifiable data on the carbon footprint of goods transport, mainly in ports operations.
Objective	The main objectives of the use case are as follows: • Analyze different transport combinations based on the carbon footprint from a standardized methodology. • Promote the use of environmental data in the citizens decision-making. • Combine information from companies, port operators and all the entities involved in the transport to calculate the carbon footprint of goods.
Reference country(ies)	Spain, Portugal, the Netherlands
Related Business Cases	Logistics, Freight operation, Port operation, Shipping, Manufacturing (generic)
Possible Stakeholders	Port operators, Shipping companies, Manufacturers, Logistics companies

3.13.3 Narrative of the use case

Society is increasingly aware of the environmental impact of transport. Carbon footprint (CF) is a key indicator commonly used to quantify the impact of human activities. Logistic and transport operations are global process where commonly multiple actors and countries are involved in the transport of a single item. For that reason, there is a huge diversity of methods for CF calculation [18]. This variety cause uncertainty and CF data are considered unreliable by citizens. This use case promotes an ODP to integrate existing information and data provided by manufacturers and transport to calculate the CF accurately in Ports operations. Ports are central to the green transition due to their role as bunkering facilities for the ships importing and exporting our goods. Their role as energy and transport hub is to become increasingly important during the green transition, given that much green hydrogen will be produced, refined and used near ports, as well as imported and exported via the ports. Ports therefore have a huge potential to provide clean energy infrastructure to the share of the maritime supply chain involved. The calculation of maritime supply chain emissions of ports is complex, given the lack of measurements and the uncertainty of shipping emissions on individual voyages and the complexity of global logistics. Ideally, in the case for freight, each product delivered to or sent from a port would have its origin and destination known, the type of ship it was shipped on with its fuel consumption on that route, with emissions associated to it. However, current methods do not account for products that are transshipped to ports without a standard accounting procedure (for example other continents) and the CF is not properly labelled from the origin, making impossible to update the cumulative emissions to specific goods and complicating decision making.

Developing a Green Logistic (GL) and Cologistic Business Platform (CBP) at European level can provide valuable information regarding logistic services offered by companies in the Euroregion Northern Spain-Portugal. A potential user interested in transport services, introduces origin and destination for a single event and the CBS offers all the available options and GL calculates the CF for each option. Therefore, the customer can choose considering cost, time, type of transport and CF. Both tools are combined in an ODP where all the entities involved in logistic can share data (before and after) and the CF of goods can be updated trusty with advance technologies like blockchain. Therefore, logistic companies would increase the visibility and increase the competitiveness with better green policies. Finally, the end consumers will receive products with a reliable CF label that includes the CF life cycle.

Figure 3.13-1. The framework of the use case 13.

3.13.4 Diagram of the use case

The diagram of the use case 13 is presented in Figure 3.13-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table *3.13-4*, respectively.

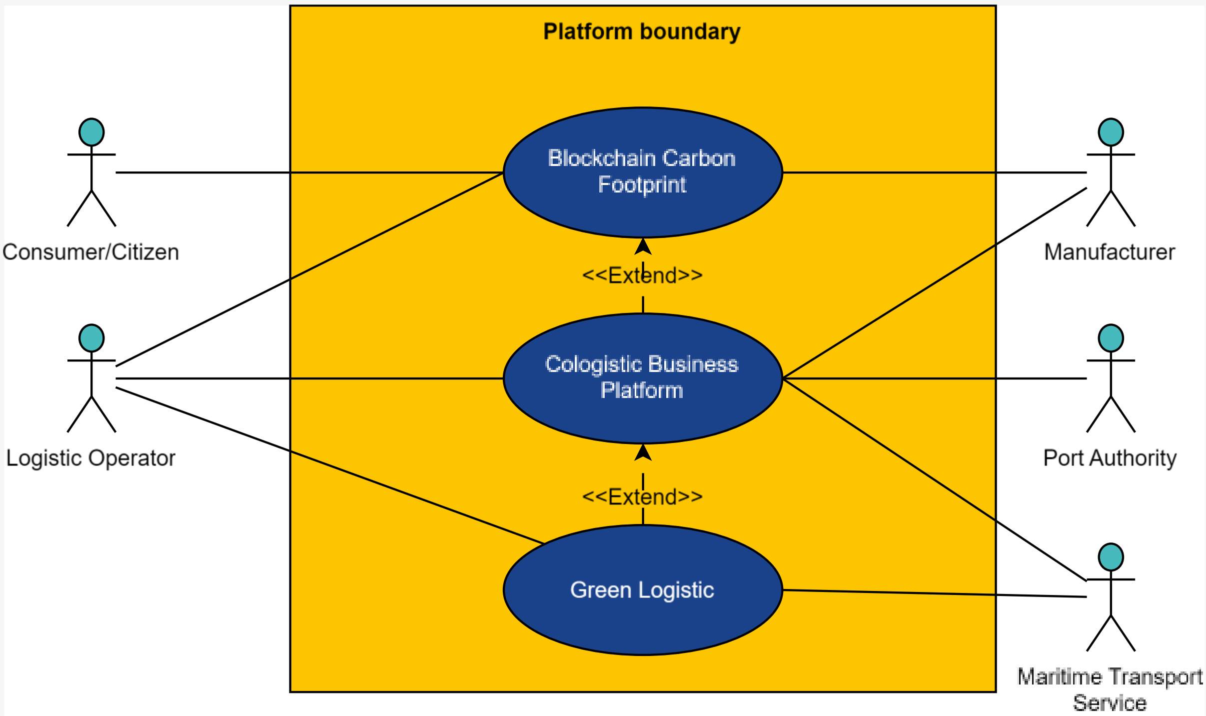

Figure 3.13-2. The diagram of the use case 13.

3.13.5 Actors of the use case

Table 3.13-3. Description of the actions of use case 13 actors

Actor Name	Actor Type	Actor description	Actions	Standards
Manufacturer	Role	Generic manufacturer of goods that require maritime transport and logistic services	It registers the carbon footprint of its products at the final point of manufacture. Check out the CBP to find the logistics operator with the best price/emissions ratio.	No
Consumer/Citizen	Role	Consumer of goods	Check the final carbon footprint of their products (e.g., QR code) in the platform.	No
Logistic Operator	Role	Support companies with transportation, storage, shipment, and distribution of goods	Access the CBP to offer different transport mechanisms and routes. Access the GL to audit CF of maritime transport services. Check the historical CF of transport operations.	No
Maritime Transport Service	Role	Waterborne transport of goods (cargo) via waterways	Register the energy consumption (e.g. fuel) of	No

			transport operations (routes, duration, load…)	
Port Authority	Role	Public manager of the port (operation and maintenance)	Access the CBP to know the CF impact of different transport operations to/from the port	No

3.13.6 Scenarios

Table 3.13-4. Description of use case 13 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.13.S1	New route completed	Route completed: goods have arrived at the destination port	The transport service accesses the platform and register the route updates, arriving time and remaining fuel/energy. The platform update the CF of goods transported and inform logistic operators and Port Authorities involved. The customer can track the carbon footprint of his order if the manufacturer (or seller) has provided him with the code.	Maritime Transport Service
BEG.13.S2	Audit Port CF operations	The Port Authority audits the annual CF of transport operations	Download of annual CF indicators and savings (in case of smart services)	Port Authority

3.13.7 Policy and digitalisation needs

Table 3.13-5. Description of use case 13 policy and digitalisation needs.

Policy needs	• Support the application of common methodologies and procedures to measure and estimate the carbon footprint in port operations across the life cycle. • Alignment of standards with the International Maritime Organization guidelines. • Require ports to regularly report their carbon emissions to national and European authorities. • Provide financial support for ports to invest in digitalization and green technologies through EU funds, national grants, and public-private partnerships. • Foster collaboration between European ports and international stakeholders to share best practices and technologies. • Support capacity-building initiatives to equip port authorities and staff with the necessary skills and knowledge for effective carbon management and digitalization.
Digitalisation needs	• Establish systems for comprehensive data collection covering all aspects of port operations, including logistics, transportation, and energy use. • Invest in the digital infrastructure necessary for real-time monitoring of carbon emissions, such as IoT sensors and data analytics platforms. • Integrate data from various sources to create a holistic view of the port's carbon footprint.

	• Implement robust data privacy and security measures to protect sensitive information while ensuring data integrity and accuracy.

3.14 Use case 14: Inland waterways multimodality

3.14.1 Use case identification

Table 3.14-1. Identification of use case 14.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.14	Inland Waterways Multimodality 4.0	☒ Local ☒ Regional ☒ National ☒ Cross-border ☐ Outermost	☐ Customer ☐ DER ☐ Distribution ☐ Transmission ☐ Generation	☒ Customer information ☒ Vehicle ☐ Energy station ☒ Infrastructure ☒ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

3.14.2 The scope and objectives of the use case

Table 3.14-2. Scope and objectives of 14 use case.

Scope and Objectives of the Use Case	
Scope	The current context of decarbonization across sectors, guided by European legislation such as the European Green deal, sets an unprecedented need for the transport sector to drastically reduce green-house gas (GHG) emissions. This includes various perspectives, such as: • The shift towards transport modes that have lower emissions, such as railways and inland waterway transport. • The electrification of transport modes. • The use of lower emissions fuels. • The improvement of transport infrastructure asset management workflows. • The improvement of the connections among transport modes, fostering multimodality of both transport users and goods. In this scenario of changes in the transport sector, the Inland Waterways Multimodality 4.0 use case fosters the creation of an ODP to align the miscellaneous stakeholders and services that are required to operate inland waterway transport and their connection with other transport modes such as railways, roads and maritime transport. The aim of the use case is the interconnection of data from sources such as transport operators (across modes), inland waterways management authorities, logistics nodes operators (mainly ports) and other infrastructure managers. Thereby, Inland Waterways Multimodality 4.0 provides a framework to foster the use of inland waterways and their connection to greener transport modes such as railways. It also provides the means for enhanced operation of inland waterways (addressing both infrastructure management and water management) and traffic flows, addressing the need of the selection of lower emissions modes. In summary, the use case seeks to establish a robust platform for sharing and consuming goods and passenger data as well as infrastructure data, fostering low emissions and efficiency in the transportation sector.
Objective	The main objectives of the use case are as follows:

	1. The provision of real-time traffic and logistics updates to inland waterways and port operators, facilitating informed decision-making and improving the connection across transport modes. 2. The seamless integration of platform services in order to support transport operators in decision-making processes when choosing among transport modes, with enhanced user experience and references to transport emissions. 3. The enhancement in passenger and goods transport efficiency by offering route recommendations based on availability and carbon footprint. 4. The provision of alerts and warnings to transport operators so as to avoid bottlenecks in the logistics chain and ensuring the safety at all points. 5. The provision of integrated information for the dynamic interexchange between transport operators and infrastructure managers, so as to reduce the impact of maintenance in traffic flows (for instance, at logistics nodes such as ports) and to manage water resources optimally (for instance, at inland waterways locks). 6. The implementation of robust data privacy measures to safeguard passengers and goods information and ensure regulatory compliance.
Reference country(ies)	Belgium, Netherlands, Austria and Romania, apart from other countries across the Rhine-Danube CEF inland waterway corridor
Related Business Case	*Inland Waterway Transport, Traffic management, Infrastructure Maintenance, Logistics, Pollution Control*
Possible Stakeholders	Transport operators, Inland waterways management authorities, Logistics nodes operators (mainly ports), Infrastructure managers.

3.14.3 Narrative of the use case

The European Green deal and the related legislation establish clear goals for the decarbonization of the transport sector, as well as the adoption of clear goals to preserve the environment and the biodiversity of species in spaces affected by transport modes such as oceans and inland waterways [19]. These guidelines include various perspectives, such as (a) The shift towards greener transport modes, such as railways and inland waterways; (b) The electrification of transport modes; (c) The use of lower emissions fuels; (d) The improvement of transport infrastructure asset management workflows; (e) The fostering of multimodality for both users and goods.

The Inland Waterways Multimodality 4.0 use case tackles the changes towards a greener transport infrastructure sector by creating an Operational Data Platform to connect the variety of stakeholders and services that are required to operate multimodal transport services in inland waterways, including transport modes such as railways, roads and maritime transport; transport and logistics operators; and logistic nodes authorities, among others. The platform has the following objectives and services:

1. Real-time provision of traffic and logistics information.

The Operational Data Platform aims to provide transport authorities and transport operators with the necessary real-time information to manage traffic and logistics information, especially at key points such as the interfaces in locks and ports, in order to foster multi-modality, improve efficiency and reduce related carbon emissions.

2. Seamless integration of information for the decision-making when selecting particular transport modes.

The provision of information on transport routes including inland waterways will make this mode of transport more efficient and competitive against other transport modes such as roadways. Furthermore, the provision of information related to carbon emissions should provide extra parameters to be taken into account in the decision-making process for transport and logistics operators.

3. Provision of alerts and warnings to transport operators to avoid bottlenecks in the logistics chain.

The platform aims to integrate an alarm system, providing information related to potential problems with infrastructure, accidents or weather conditions, among others. The aim is to avoid bottlenecks in particular points such as locks or port entrances.

4. Coordination of transport infrastructure maintenance with traffic flows in inland waterways.

The coordination of transport infrastructure maintenance (especially at critical points such as ports and locks) with the planning of logistics and passenger flows is critical to improve transport flows in linear infrastructures such as inland waterways. The Operational Data Platform aims to improve this exchange of information to allow a better planning.

5. Coordination of traffic flows at key navigation points and logistics nodes for green navigation.

The coordination within the inland waterway between the infrastructure operators (such as locks, doors, etc.) and the ships operators is to reduce waiting times and, thereby, reduce carbon emissions, by connecting more efficiently the decisions on water levels, barge speeds and opening and close times of gates.

6. Development of robust data management and security measures.

The platform is to provide a seamless exchange of data with no security implications for the different owners of the data.

7. Integration with environment-related sources of information and stakeholders for the preservation of biodiversity.

The EU 2030 Biodiversity Strategy sets the target to build a coherent Trans-Europe Nature Network [20]. This must be coordinated with critical ecosystems such as inland waterways and heavily pollutant nodes such as ports. Thereby, information on pollution is to be shared in the platform, so as to study and limit its effect on protected species.

The use case has a relevant cross-border component, given the main inland waterways in Europe cross several countries. Thereby, the use case is of clear application to the Rhine-Danube CEF corridor, connecting several countries across central and east Europe.

Figure 3.14-1. The framework of the use case 14.

3.14.4 Diagram of the use case

The diagram of the use case 14 is presented in Figure 3.14-2. Actors' actions and scenarios' descriptions are presented in Table 3.8-3. and Table 3.8-4., respectively.

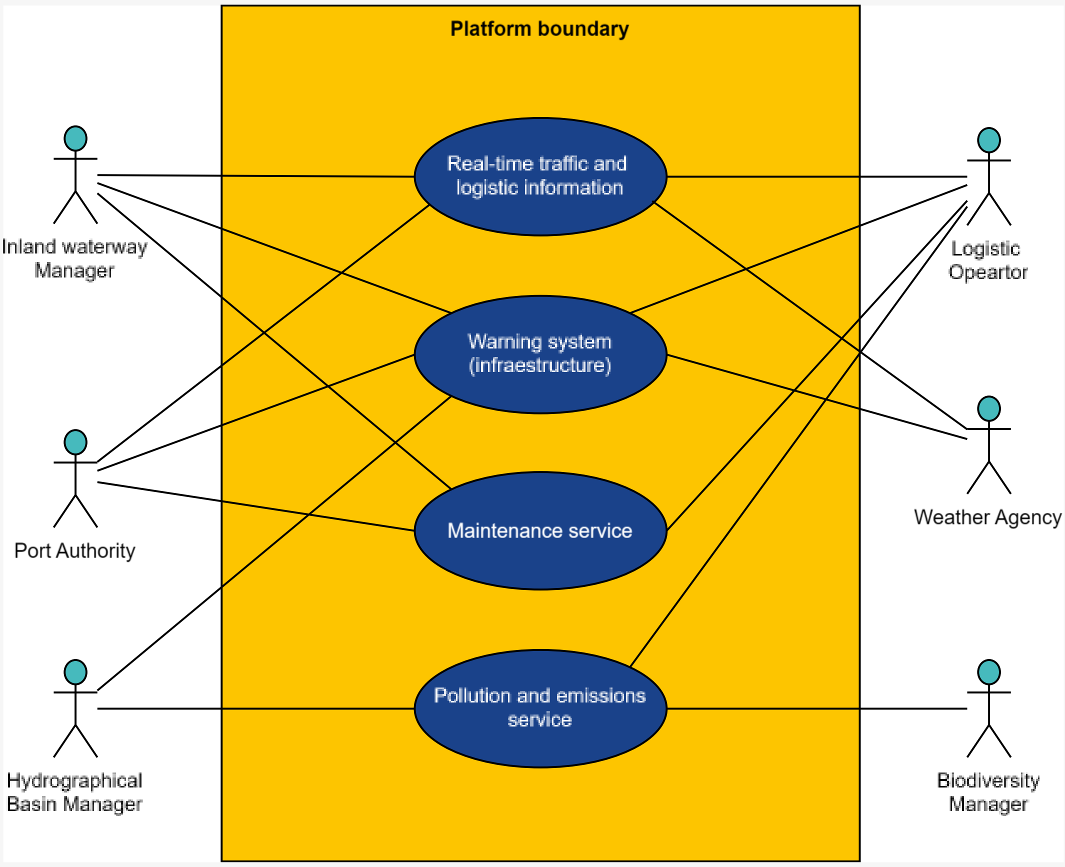

Figure 3.14-2. The diagram of the use case 14.

3.14.5 Actors of the use case

Table 3.14-3. Description of the actions of use case 14 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
Inland Waterway Manager	Role	Government agencies or departments responsible for planning, maintenance, and regulation of inland waterway networks.	Develop and implement traffic management policies, maintain infrastructure, deploy traffic control systems, conduct safety assessments, and coordinate with other stakeholders.	No
Port Authority	Role	Public and/or private companies in charge of the management of port infrastructures.	Coordinate the different stakeholders in a port area, including infrastructure managers, transport operators, government agencies or passengers.	No
Hydrographical Basin Manager	Role	Government agencies responsible for preserving the group of rivers and water sources in a particular area or basin.	Manage and preserve the rivers and underground water in a particular area or region.	No
Transport and logistics operator	Role	(Private) organizations responsible for managing and operating the transport	Manage the movement, storage, and distribution of goods and/or passengers across various transportation	No

		of passengers and goods.	modes and supply chain networks.	
Weather Agency	Role and System	Agencies responsible for the prediction of weather in a particular area.	Monitor and forecast meteorological conditions to provide accurate weather information and warnings.	No
Biodiversity Manager	Role	Government agency responsible for preserving the ecosystem of a particular area or region.	Oversee conservation efforts, habitat restoration, and species protection to maintain ecological diversity.	No

3.14.6 Scenarios

Table 3.14-4. Description of use case 14 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor
BEG.14.S1	Accident Notification	Information systems on (e.g.) a lock detect a failure in infrastructure or an accident.	The sensors in a port/lock detect an incident and automatically send notifications to the federated platform. The platform validates the incident, cross-referencing it with the information provided by transport operators. Once confirmed, the platform sends alerts to other transport operators and actors to shift traffic in the inland waterway or port area.	Port authority or inland waterway manager systems.
BEG.14.S2	Notification of port infrastructure intervention	Maintenance begins in a particular infrastructure asset such as a quay wall.	The maintenance operator reports the state of works to the infrastructure asset manager via the platform. The platform provides real-time notifications, which are transmitted to transport operators. Transport operators receive valuable insights that allow them to adjust routes or schedules.	Port authority or inland waterway manager.
BEG.14.S3	Weather Hazard Detection	Extreme weather conditions arise, for instance, low water levels, waves, heavy rain, extreme wind, etc.	Adverse weather conditions affect the integrity of certain infrastructure assets and, most importantly, navigability in port areas, where interexchange occur. This information is received in the platform and it is transmitted to the transport operators and infrastructure managers to adapt depending on risk levels.	Infrastructure managers. Weather agencies.
BEG.14.S4	Oil Spill	Commercial barge spills oil in a port environment.	A barge in a port area spills oil due to an accident or mechanical problem. This problem is reported to the platform. Port authorities establish a safety procedure due to the spill and the potential problem on the barge. Governmental entities in charge of	Port authority. Transport operator.

			biodiversity analyse the situation. Transport and logistics operators follow procedures, avoiding the area.	

3.14.7 Policy and digitalisation needs

Table 3.14-5. Description of use case 14 policy and digitalisation needs.

Policy needs	**Minimum Regulatory Framework** • **Data Privacy and Security Regulations:** Implement robust measures to ensure the protection of personal data, adhering to GDPR and other relevant privacy laws. • **Liability and Insurance Regulations:** Clarify liability issues related to incidents and accidents involving connected systems, defining the responsibilities of operators, service providers, and infrastructure authorities. **Current Barriers** • **Fragmented Regulatory Landscape:** Inconsistent regulations across countries hinder the seamless deployment of an Operational Data Platform for inland waterways across Europe, requiring harmonization efforts and cross-border cooperation. • **Infrastructure Investment:** The implementation of the Platform, including infrastructure sensors and communication networks, requires significant investment and collaboration between public and private stakeholders. **Legal and Social Factors** • **End-user Acceptance:** Addressing end-user perceptions and attitudes towards connected inland waterway transport is crucial to fostering its use, highlighting the benefits in terms of safety, efficiency, and carbon emissions. **Regulatory Compliance:** • Compliance with evolving regulatory requirements, including emission standards, is essential to ensure the legal operation of an Operational Data Platform connecting several stakeholders across the inland waterway transport domain.
Digitalisation needs	**Data Integration and Management** • Data Volume and Variety: Managing the large volume and variety of data required in logistics processes across transport modes and countries. • Real-Time Processing: Ensuring the capability to process and analyze data in real-time to provide timely and accurate information for transport operators and other stakeholders. **Connectivity and Network Infrastructure** • Network Coverage: Ensuring comprehensive network coverage, especially in rural and remote areas, to support all points within inland waterways. **Security and Privacy** • Cybersecurity Threats: Implementing advanced cybersecurity measures to protect the network and user data from cyber-attacks.

	• Data Encryption: Ensuring end-to-end encryption of data to maintain confidentiality and integrity during transmission and storage. **Cross-Border Data Exchange** • Harmonized Standards: Establishing harmonized standards for data exchange across different countries and stakeholders to ensure seamless cross-border interoperability. • Regulatory Alignment: Aligning regulations related to data privacy, security, and insurance across different jurisdictions to facilitate cross-border operations. **Multi-Stakeholder Collaboration:** • Stakeholder Coordination: Coordinating among various stakeholders, including transport operators, infrastructure authorities, infrastructure managers or river managers, to ensure smooth collaboration and data sharing. **Data Sharing Agreements** • Developing clear data sharing agreements and frameworks to facilitate collaboration while protecting proprietary and sensitive information.

3.15 Additional use cases

In addition to the 14 above-mentioned use cases, some other use cases were collected during the interviews and research. Since these use case cannot cover the whole requirements of the project use cases in terms of idea, scale, number of involved stakeholders, etc. they are not considered as the final selected use cases. However, to give an insight about other possible use cases, a brief description of these use cases are presented in Table 3.15-1.

Table 3.15-1. A brief review on additional use cases.

BEG.15	**Title: BRP-level aggregator platform for local EU flexible communities** **Brief description:** This use case proposes a standardized ODP that enables aggregation of cross-sector flexible resources from different communities that are in contract with the same balancing responsible party (BRP). The proposed ODP allows the communities to negotiate with their the BRP and agree on using their resources to keep the BRP's portfolio in balance. The agreement can be in the form bilateral contracts or market-based. The platform will be designed according to EU regulations for modern utility services and will allow each BRP using the platform to customize it according to their local regulations for several countries.
	Title: Big data analysis platform for energy cummunities **Brief description:** Energy Community is a complex setup demanding its participants to produce, supply, consume, store, and distribute clean energy, including renewable energy sources, as well as to provide electric mobility, energy efficiency or other energy services. The recent increased demand in

BEG.16	decision support tools to help investors to find most suitable locations and operating conditions for establishing new or upgrading existing energy communities led to development of variety of tools that either have a limited depth of analysis or are specific to a certain region within EU. To increase attractiveness of specific locations in EU member states for potential investors in energy communities while keeping the general overview, this use case develops a big data collection and analysis platform accessible online in all member states. This operational data platform (ODP) collects the data from GDPR-secured sources (based on the data-source documentation from data providers) about the renewable assets within a set of Residential or Commercial Energy Consumers and estimates its potential and cost for being converted to the energy community. The analysis of the EC commercial potential is done on demand for each member state from the point of view of Levelized cost of energy by attracting regional authorities and local electrical service consultants from local TSO/DSO/utility companies.
BEG.17	**Title: A platform for supporting crossborder offshore renewable energy projects** **Brief description:** Our primary objective is to gather and provide comprehensive information to support potential crossborder offshore renewable energy projects that would benefit countries sharing the same border. Looking at, for instance, the Iberian Peninsula, considering that the Portuguese and Spanish grids are interconnected, integrating the Spanish grid with other countries would also be advantageous for Portugal. This interconnected approach would enhance the overall efficiency and reliability of the energy networks, promoting sustainable energy solutions and reinforcing cross-border cooperation. This use case will contribute to accommodate the increasing penetration of offshore renewables thus creating a more integrated and resilient energy infrastructure that can better serve the needs of both Portugal and its neighbouring countries, ultimately supporting the broader objectives of energy sustainability and cross-border collaboration within the EU. Three demonstration cases are considered for this use case: 1) Connection of a 1GW offshore wind farm on the northern border of Portugal and Spain, 2) Connection of a 1GWp offshore Floating PV farm in the southern border of Portugal and Spain, 3) Connection of a 1GW offshore wind farm in the golf of Leon, between Spain, France, and, possibly, Italy. Studying the most beneficial kind of connection between countries, the costs and benefits of countries, the energy market and synergies in terms of skills, supply chain, ports and infrastructures are some of the main features f the proposed use case.
BEG.18	**Title: Traffic flow management system for overpopulated islands and archipelagos (Spain)** **Brief description:** This use case is inspired in the context of Canary Islands (Spain). The archipelago addresses sever traffic congestions at the entrance to cities and at critical points such as tunnels and viaducts due to the inner overpopulation and passenger/tourists flow between islands and external arrivals. The traffic control system currently is not supported by external data (hotel reservations, flights, sea crossing…) either real time information to o react to changes quickly and avoid undesired incidents. An ODP that integrates data from tourists' bookings, including destination, weather conditions, real traffic information…, and integrated with traffic signaling systems and coordinated with traffic agents may mitigate the situation in a cost-effective manner. The definition of an architectural model to replicate the platform in other islands and interconnect them in a common system is also beneficial to integrate more information, evaluate and share good practices and deploy advanced technologies (e.g. IA) to improve the management in a comprehensive manner.
	Title: Digital platform for the decarbonisation of ports and their integration into electricity markets

BEG.19	**Brief description:** Europe is aware of the need to decarbonize ports, and to this end, it has set very ambitious targets to achieve electrification, integration of renewable sources, and green hydrogen. However, for proper planning, deployment, and supervision, it remains necessary to deploy platforms that monitor energy consumption (among other sources like water). This use case is related to BEG.01 and is specific to ports to address the climate change and environmental challenges set by the European Commission. Increasing the capacity to observe energy and water consumption at different levels of granularity (machinery, lighting, vehicle recharging, etc.) through digital platforms will allow the adoption of management models adapted to the various scenarios of European ports, both maritime and fluvial, and ensure their long-term management and supervision. Additionally, thanks to digital platforms that monitor and manage the energy resources of ports, it is possible to standardize an energy hub model that allows the exploitation of the energy flexibility of ports towards cities and the national electricity market. This ensures that their energy capacity is available for port operations and for the energy management of electrical systems in general.

4. Preliminary SWOT (Strengths, weaknesses, Opportunities, Threats) analysis of use cases

To have a better understanding of the positive and negative aspects of the proposed use cases in section 3, a preliminary SWOT analysis is performed in this section. This analysis was done in three steps. First, a SWOT analysis was done by experts, then, the use cases were revised to address the weaknesses and threats of the use cases' presentation, and finally, the SWOT analysis was updated accordingly. The final SWOT analysis results are presented in Table 4.1-1 to Table 4.1-10.

Table 4-1 SWOT analysis results of the use case BEG.01.

Strengths	• One-stop-shop: By providing a centralized hub for accessing digital twins, real-time data, and planning tools, the use case enhances convenience and efficiency for DSOs and grid operators. • Real-Time Monitoring and Decision Support: By leveraging digital twins and microservices, he use case supports proactive decision-making and optimization of grid operations, enhancing reliability and efficiency. • Solutions for demand-side flexibility procurement: By providing the possibility of interaction between the platform, DSO, different CLs, and end-users, demand side flexibility can be used for solving grid issues.
Weaknesses	• Scalability: it does not provide detailed information on scalability or scalability strategies.

	• Lack of cross-border feature: The use case is defined for reginal and national levels implementation and does not cover the cross-border aspect.
Opportunities	• Standardisation of data exchange and ontologies to integrate digital twin support the EU common European market. • Extend the concept to consider dynamic loads and interact directly with them. For example, dynamic power contracts with EV charging points, adding the transport aspect. • Observability problem may improve with the digital twin. Continuous observability→predictive maintenance
Threats	• Security breaches could disrupt system monitoring, control, and communication processes, leading to service interruptions or unauthorized access to critical infrastructure. Specify how to solve this issues.

Table 4-2 SWOT analysis results of the use case BEG.02.

Strengths	• It integrates data centres with district heating and ancillary services (cross-sector). The ODP is connecting different business. The use case offers opportunities for DC owners to monetize their operations through the optimization of energy storage and waste heat reuse, potentially generating revenue through ancillary services provision. • The ODP enables real-time monitoring of DC operations and key performance indicators (KPIs), facilitating prompt decision-making and enhancing operational agility.
Weaknesses	• Implementation challenges: Developing and implementing the ODP may face technical complexities, integration issues, and stakeholder resistance (too many actors involved) • Limited interoperability and scalability: Inadequate interoperability and scalability features may restrict the ODP's ability to integrate with diverse data sources and accommodate future growth. • It lacks the cross-border perspective.
Opportunities	• The use case can leverage its one-stop-shop solution and real-time monitoring capabilities to offer monetization opportunities, such as providing value-added services and selling data insights to other sectors. • Enhanced utilization of cross-sector data: Leveraging cross-sector data sources enables the use case to provide comprehensive insights and solutions, fostering innovation and attracting a diverse customer base.
Threats	• *All the threats found in the preliminary SWOT analysis have been sorted out.*

Table 4-3 SWOT analysis results of the use case BEG.03.

Strengths	• End-users are well-defined. There are consolidated entities that would be interested in the deployment of the pilot.

	• With the trucks being the 22% of GHG emissions, use case is able to establish real KPIs. • Cross-sector and Transnational perspective are well defined. • Real-Time Monitoring and Updating: Enables real-time monitoring of charging stations and grid conditions, allowing for immediate adjustments and optimization of charging schedules.
Weaknesses	• Resistance to Data Sharing: Companies may be reluctant to share internal data such as charging requirements and truck routes, limiting the platform's capabilities. • Lack of cross-border feature: The use case is defined for reginal and national levels implementation and is not capable of providing the cross-border solutions.
Opportunities	• Expansion of Services: The platform can expand its services to other sectors beyond industrial parks, such as transportation hubs and logistics centers. • Attracting investment from public and private sources to expand and upgrade charging infrastructure in industrial parks can create employment opportunities, stimulate economic growth, and accelerate the deployment of ETs, thereby reducing greenhouse gas emissions and improving air quality, with affordable KPIs. • A economic compensation for ET owners could be included in case of problems with the planned charging
Threats	• *All the threats found in the preliminary SWOT analysis have been sorted out.*

Table 4-4 SWOT analysis results of the use case BEG.04.

Strengths	• The USE CASE incorporates cutting-edge technologies such as AI and predictive analytics to address challenges in EV charging infrastructure, showcasing a progressive adoption of advanced technologies. • By promoting EV usage and integrating renewable energy into charging infrastructure, the use case directly contributes to the transition towards a more sustainable transportation sector, a key objective of BEGONIA. • Addressing EV charging in cross-border traffic areas fosters cooperation between neighboring countries, laying the groundwork for future transnational collaborations in energy and mobility.
Weaknesses	• Intermittency of Renewable Sources: solar and wind energy for charging infrastructure introduces challenges due to their intermittency, potentially leading to periods of insufficient renewable energy supply, which may hinder the effectiveness of the charging network. • Forecasting shortages, overgeneration, etc. • The accuracy of predictive analytics models used to forecast renewable energy production and EV charging demand may be limited by the complexity of underlying factors such as weather patterns, traffic patterns, and user behavior. • Depending on the dataset (3-4 years to have a good model)

	• Building and maintaining the necessary infrastructure for cross-border EV charging, including charging stations, energy storage systems, and communication networks, requires significant investment. • A general one. Depending on the states involved. There is existing infrastructure. We can give a forecast about the investment.
Opportunities	• By using predictive analytics and dynamic pricing to manage demand, the use case can contribute to grid stability, optimizing the integration of renewable energy sources into the grid. • Road operators can provide valuable data on traffic patterns, congestion hotspots, and peak travel times, which can be leveraged to optimize charging schedules and manage EV demand more effectively. • Collaboration with road operators fosters opportunities for revenue generation through value-added services such as premium charging locations, priority access lanes for EVs, and advertising partnerships. By monetizing these additional services, the use case can create sustainable business models.
Threats	• Regulatory barriers related to data sharing, pricing structures, and cross-border cooperation may hinder the implementation and scalability of the use case, posing a threat to its effectiveness in addressing cross-border EV charging challenges. • GDPR is very strict. Personal data is critical. Consider mobility data from users. How many EVs are on the road, not personal data. • The fragmented nature of the EV charging market, with multiple stakeholders including energy providers, charging station operators, and EV manufacturers, may lead to competition, conflicts of interest, and lack of standardization.

Table 4-5 SWOT analysis results of the use case BEG.05.

Strengths	• Facilitates cross-border transactions and roaming services, promoting seamless mobility for EV owners across EU countries. • Utilizes predictive analytics, machine learning, and IoT for real-time data exchange and optimization of charging services.
Weaknesses	• Interoperability Challenges: Ensuring interoperability between different EV models, charging stations, and grid operators across EU countries presents a significant challenge. • As the number of EVs and charging points continues to grow, scalability becomes a critical concern for the ODP. Ensuring that the platform can accommodate increasing transaction volumes, user interactions, and data processing requirements without compromising performance or user experience is essential. • AI prediction tools for the flexibility are not well defined, elaborate further is desired.
Opportunities	• Integration with road operators, smart city initiatives, and transportation networks enhances interoperability and promotes holistic urban mobility solutions.

	• Collaborating with road infrastructure providers, such as highway operators and rest area managers, presents an opportunity to integrate EV charging facilities into existing transportation networks. • By anonymizing and aggregating data insights, the platform can offer valuable analytics services to stakeholders, such as energy companies, policy makers, and urban planners, driving additional revenue streams and creating economic value from data assets.
Threats	• *All the threats found in the preliminary SWOT analysis have been sorted out.*

Table 4-6 SWOT analysis results of the use case BEG.06.

Strengths	• The use case focuses on developing a cross-border ODP for flexibility aggregation and trading at the EU level. This cross-border integration enhances collaboration between different countries. • Introducing a market mechanism for trading flexibility among EU member states provides new market opportunities for aggregators and facilitates the efficient utilization of demand-side flexibility.
Weaknesses	• Ensuring interoperability and compatibility between different aggregator systems, DSOs, and TSOs across borders can be complex. • Despite the potential benefits, demand-side flexibility solutions such as demand response and load shifting may face challenges in adoption and participation. Factors such as consumer behavior, market incentives, and technology maturity could impact the uptake of demand-side flexibility services. • Regulatory constraints and differences across EU member states may pose challenges to the implementation of a cross-border ODP for flexibility aggregation and trading. Varying regulations regarding flexibility markets, data sharing, and market access could hinder the seamless integration of flexibility resources.
Opportunities	• The push for greater integration and harmonization of energy markets within the EU presents an opportunity to streamline regulations related to flexibility trading. Alignment of regulatory frameworks across member states can facilitate cross-border cooperation. • The establishment of a cross-border ODP opens up new market opportunities for aggregators operating in the flexibility space. Access to a larger pool of flexibility resources and participation in regional flexibility markets can enhance revenue streams and business prospects for aggregators. • The use case can empower prosumers to monetize their distributed energy resources by participating in flexibility markets and contributing to grid balancing efforts.
Threats	• The concentration of market power among dominant players, such as large aggregators or energy incumbents, could distort competition and inhibit market access for smaller players.

Table 4-7 SWOT analysis results of the use case BEG.07.

Strengths	• The platform can facilitate efficient and streamlined energy provider switching processes, potentially reducing costs associated with manual interventions and paperwork, leading to financial benefits for both consumers and energy providers. • The platform's automated workflows optimize time and resources by minimizing the need for manual intervention, ensuring faster and more efficient energy provider switching processes. • Through transparent communication and documentation of energy provider switching processes, the ODP fosters greater market transparency, enabling fair competition and equitable access to energy services for consumers and providers alike.
Weaknesses	• The focus of the use case on energy provider switching processes may result in limited integration with transport sector. • Integrating the ODP with existing energy market systems, metering infrastructure, and consumer databases across multiple EU member states poses a significant technical challenge. The diverse architectures, protocols, and data formats used by different stakeholders may require extensive customization and interoperability testing.
Opportunities	• The deployment of use case presents an opportunity for energy providers to expand their market reach and attract new customers by offering streamlined and hassle-free switching processes. • The use case empowers energy consumers with greater flexibility and control over their energy choices by enabling swift and seamless switching between providers. This increased freedom of choice can lead to higher levels of consumer satisfaction. • The introduction of automated switching processes facilitated by the use case fosters a more competitive energy market environment, driving innovation, efficiency, and price transparency. • The implementation of the use case generates valuable data insights regarding consumer behavior, preferences, and switching patterns. Energy suppliers can leverage this rich data pool to gain deeper customer insights, refine marketing strategies, and tailor energy offerings to better meet evolving consumer needs and expectations. Additionally, data analytics can help identify market trends, opportunities, and areas for optimization.
Threats	• The automated switching processes facilitated by this use case involve the exchange of sensitive consumer data, including personal and financial information. As such, there is a heightened risk of data breaches, cyberattacks, and unauthorized access to customer records. Any security vulnerabilities within the ODP or associated systems could compromise the confidentiality, integrity, and availability of consumer data, leading to financial losses, reputational damage, and regulatory penalties. • The introduction of automated switching processes may face resistance from traditional energy providers, regulatory bodies, and consumer advocacy groups accustomed to conventional manual procedures. Stakeholder resistance, reluctance to adopt new technologies, or skepticism about the benefits of this use case could hinder its widespread acceptance and adoption.

Table 4-8 SWOT analysis results of the use case BEG.08.

Strengths	• Monetization: The platform facilitates power trading of energy among various stakeholders, enabling monetization opportunities for RES owners, EV charging stations, and CLs. • The platform utilizes advanced data-driven methods and AI-based approaches for forecasting RES output, EV charging demand, and load consumption, enabling real-time monitoring and updating of KPIs for efficient operation.
Weaknesses	• The aggregation of sensitive data from multiple sources raises concerns about data privacy and security, especially regarding GDPR compliance and safeguarding against potential cyber threats or data breaches.
Opportunities	• The establishment of partnerships with regional authorities, energy service providers, and technology developers presents opportunities for collaboration and knowledge sharing. • The deployment of this use case aligns with broader policy objectives aimed at promoting renewable energy adoption and reducing carbon emissions. Governments and regulatory bodies may support and incentivize the deployment of platforms that facilitate green energy consumption.
Threats	• The energy market landscape in Europe is characterized by fragmentation, with different regulatory frameworks, market structures, and stakeholders operating across various regions. Managing interoperability and coordination among diverse market participants and regulatory bodies may pose challenges. • The success of the platform relies heavily on user adoption and participation. Encouraging consumers, energy providers, and other stakeholders to actively engage with the platform may be challenging, especially if they perceive barriers such as lack of awareness, trust, or incentives to participate in power trading and green energy consumption.

Table 4-9 SWOT analysis results of the use case BEG.09.

Strengths	• Real use case implemented partially in the Spanish traffic management system (several years of experience). • Warner beacon light (V16) are ready to be integrated in the system in the coming years. • Working area information is already communicated commonly in the Spanish context.
Weaknesses	• The platform is only accessible by the Spanish Traffic Authority. Other Authorities or specific entities must request permission to get real-time information. • Lack of automatic integration with weather agencies (e.g. AEMET) against unexpected critical events. • Investment for deployment on secondary road networks can be difficult to justify.

	• Decentralization in some spanish authorities (Traffic is for Ministry of Interior and Infrastructure management is for Ministry of Transports) could be an obstacle for the correct development of the use case.
Opportunities	• Platform standardization to other countries through European regulations in order to extend functionalities in cross-border conditions and beyond. • Integration of more stakeholders would make the platform more robust and increase the social utility
Threats	• Other similar platforms and navigators (Tomtom, Google…) may reduce the interest on investing in a common EU traffic flow control system

Table 4-10 SWOT analysis results of the use case BEG.10.

Strengths	• New business models (insurance companies) can be developed to improve the safety and comfort of drivers. • New predictive models can be deployed to anticipate events to avoid accidents. • Improving competitiveness (dynamic tariffs) and alliances between insurance companies on cross-border conditions. • Improve the driver behaviour while respecting privacy principles. The user make the decision about the data shared.
Weaknesses	• Vehicle communication coverage may be poor on secondary roads, in tunnels or in natural areas.
Opportunities	• Companies with a fleet of vehicles can access new advantages in monitoring and guaranteeing their logistical processes and the movement of their employees. • Liabiility of a mulhi-vehicle accident will be easier to determine, thus optimizing the agreements between the different companies involved. • Partnering with vehicule manufacturers enhance the value proposition of the platform
Threats	• Drivers may consider the system to be an attack on their privacy (lack of acceptance). Besides, they can be afraid of premium tariffs based on their driving. • Transnational insurance companies may not be interested in such platforms.

Table 4-11 SWOT analysis results of the use case BEG.11.

Strengths	• Drone-based inspections is a cost-effective procedure to maintain linear infrastructure that minimize the safety risk of operators. • It is compatible with EASA regulations and principles. • Improve the competitiveness of drone operators at EU level. • Improve the maintenance and safety of EU linear infrastructures.

Weaknesses	• Integrating blockchain technology with existing regulatory systems and ensuring compatibility across different regions and authorities can be technically complex and resource-intensive.
Opportunities	• The authorisation platform may be effective for other contexts based on drone services, like agriculture, construction, or environmental monitoring, providing new business opportunities.
Threats	• It must be supported by regulations (e.g. EU mandates) to reduce the validation time across different legal authorities. Otherwise, efficiency and value proposition for the platform will be undermined.

Table 4-12 SWOT analysis results of the use case BEG.12.

Strengths	• FIWARE is the Open Source Platform accepted by CEF programme. • Improve the logistic operations within ports and inland waterways, reducing the time and needed space for operations, and making it safer for staff. • Higher accuracy of performance indicators (e.g. environmental).
Weaknesses	• Drone flights may require special authorization for the use case purpose (see BEG.11)
Opportunities	• Deployment in FIWARE guarantees the replicability and scalability in EU ports and inland waterways. • In combination with BEG.13, this use case may become a standard platform to improve the performance operation of European ports.
Threats	• Competitiveness between different ports may jeopardize the real implementation, especially in CEF corridors.

Table 4-13 SWOT analysis results of the use case BEG.13.

Strengths	• It is aligned with EU policies (e.g. Green Deal) to reduce carbon emissions through electrification of port operations. • Improve the user information and increase the competitiveness of maritime transport services • Support the decision making of logistic companies and port authorities.
Weaknesses	• Real-time monitoring depends on the automation level of the value chain since different stakeholders must update the information during transit for the service to deploy its full functionality.
Opportunities	• Other logistic means (rail and road transport) can benefit from the carbon footprint monitoring system, as well as other solutions involving product life cycle analysis.
Threats	• For actual deployment there must be a prior consensus on the methodology for calculating emissions under different transport conditions.

Table 4-14 SWOT analysis results of the use case BEG.14.

Strengths	• It is aligned with EU policies (e.g. Green Deal) about the decarbonization and environmental protection of CEF corridors. • Increase the reliability and safety of inland waterways operations
Weaknesses	• Unclear the cross-border insurance service integration in the platform and support (tentative solutions in BEG.10).
Opportunities	• The environmental monitoring can be integrated with other nature protection platforms to minimize the impact of transport operations.
Threats	• For actual deployment there must be a prior consensus on the methodology for calculating emissions under different transport conditions. • The regulatory framework must be harmonized to guarantee the acceptance and implementation.

5. Conclusions

Begonia project aims to design and develop cross-border ODPs, capitalizing on existing and emerging European data, cloud, edge computing, and connectivity infrastructures to improve interoperability and standardization. The primary objective is to expedite the digital transformation of the energy and transport sectors, fostering a virtuous cycle of public-private investment partnerships. To achieve this, the project will identify and prepare use cases for deployment, conduct feasibility studies, and establish regulatory and technical frameworks for each selected use case.

Deliverable 2.1 aims to identify and prepare use cases in energy, mobility, and cross-sector energy/mobility. To this end, starting from desk research, the most appropriate fields for obtaining use cases were selected. To be sure that the use cases are aligned with needs of stakeholders, a list of stakeholders was created, a communication strategy was designed, and and interviews were conducted. Taking into account the feedback gathered from interviews and desk research, 14 use cases from 12 member states were finalized and described in detail using the use case template of standard IEC 62559.

During the interviews and desk research, 5 other interesting use cases were also found that were not selected as final use cases for reasons such as the scale and number of engaged stakeholders. A short description of these use cases was also included in the deliverable, to give an insight to the audiences about possible other cases for deploying ODPs.

A preliminary SWOT analysis was performed on the selected use cases, to highlight strengths, weaknesses, opportunities, and threats of use cases. According to the preliminary SWOT analysis results the most important barriers for implementing cross-border ODPs are regulatory barriers related to data sharing, data privacy and security, GDPR, cyber threats or data breaches, limited interoperability and scalability, technical complexities, potentially conflicting interests, and user adoption and participation.

Next 6 months (until end October 2024) the consortium will carry out the following activities (see Figure 5-1):

1. Technological research to identify the ODP components (principles, architecture and standards) that can support the implementation of most of use cases presented, aiming at designing a generic approach for cross-border and cross-sector conditions.
2. Based on the previous research, design the system architecture and governance schemes to support at high-level of the use cases presented.
3. Definition of the evaluation criteria to select the 6 most promising use cases, which will be tested against the proposed architecture and governance models next year.
4. Definition of the cost-benefit analysis methodology that will be used to include a technical-economic-social approach in the decision-making process to select the final 3 uses cases that will be piloted at the end of the project.

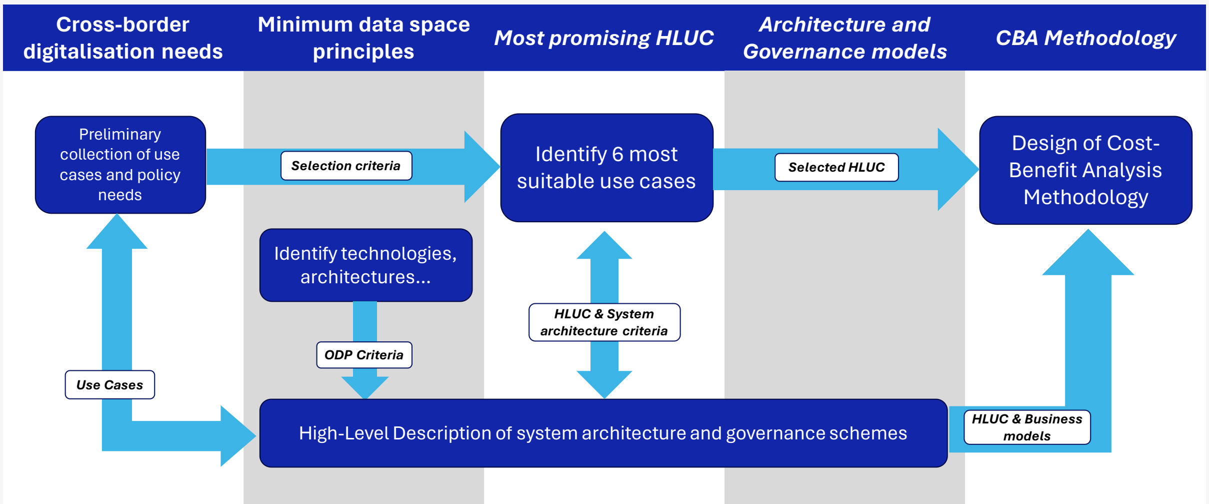

Figure 5-1. BEGONIA: next steps for shortlisting procedure and cost-benefit analysis (CBA).

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