D2.2 BROCHURE OF MOST PROMISING 6 USE CASES BASED ON TECHNICAL AND ECONOMIC FEASIBILITY

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VIEW OF THE COORDINATOR

Dear reader,

First and foremost, thank you for taking the time to read this brochure, which summarises the results achieved during the first year of the BEGONIA project. This project is funded by the EU under grant agreement number 101133306 and aims primarily to identify and pilot cross-border (UCs) in the fields of energy, mobility, and transport that could benefit from the concept of the Operational Digital Platform (ODP).

In this initial phase, 14 use cases have been identified and carefully described using the IEC 62559 methodology [1]. These were subsequently reviewed by both internal and external consortium experts, as well as other stakeholders, through interviews and questionnaires to ultimately select six candidates to be studied in a second phase.

These 6 use cases (two in energy, one in data centres, two in ports, and one in infrastructure) are briefly described and illustrated in this document. Additionally, a reference architecture scheme and a Cost-Benefit Analysis (CBA) methodology are briefly presented. These will be used in the next phase of the project for analyzing the six use cases here presented and shortlisting them to three.

If you would like more information about any specific use case, please feel free to contact the consortium. Additional details will also be available in the project's first deliverable (D2.1), which will be published soon.

Kind regards,
Razgar Ebrahimy (Project Coordinator)

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CONTENT

INTRODUCTION

DESCRIPTION OF THE PROJECT

The overall objective of the BEGONIA project is to design and develop cross-border digital platforms that enhance interoperability and standardization, accelerate the digitalization of the energy and transport sectors, and foster a virtuous circle of public-private investment partnerships.

These infrastructures will seamlessly integrate with existing and emerging European data, cloud, edge computing, and connectivity infrastructures with special attention to 5G. The project will identify potential use cases, conduct feasibility studies, develop regulatory and technical frameworks for each short-listed use case, and prepare them for deployment.

The final selection of use cases will be based on technical feasibility, regulatory compliance, and cost-benefit analysis. The aim is to achieve substantial reductions in greenhouse gas (GHG) emissions, improve the energy and environmental performance of European digital infrastructure, address and mitigate the current energy crisis, and prevent blackouts.

The project will also engage stakeholders and communities to ensure its success and long-term sustainability.

BEGONIA's workplan is designed with 3 Phases:

1. Identification and characterisation of cross-border and cross-sector use cases;

2. Selection of the six most promising use cases, proposal of an ODP architecture, and cost-benefit analysis;

3. Selection of the three highest-impact use cases, piloting (implementation), and results assessment.

Currently, Phase 1 has been completed. As a part of Phase 2, this brochure briefly describes the 6 use cases that will be analysed in detail to propose an ODP architecture and provide input for Phase 3.

INTRODUCTION

METHODOLOGY TO DEFINE THE 6 USE CASES

Five steps have been followed along 9 months to define the 6 UC presented:

1. Recruiting the most relevant stakeholders in EU related to cross-border initiatives of energy, mobility, and transport, to jointly define the most promising future UC (a total of 14 UC were collected).

2. Characterising the UC using the IEC 62559 standard to standardise descriptions, business models, and policy requirements.

3. Preparing a questionnaire, which was shared with 51 stakeholders who provided their feedback.

4. Quantifying and scoring the results through the Analytic Hierarchy Process (AHP) method to create a ranking based on criteria based on potential technical, economic, social, and environmental impacts.

5. Consensus evaluation and grouping of use cases with similar characteristics to identify six use cases with the highest possible impact at the EU level.

INTRODUCTION TO THE SELECTED USE CASES

The 6 selected use cases address the benefits that ODPs can bring to cross-border needs identified by the consortium and stakeholders; they also address the complexities of scaling up EV charging infrastructure across national borders, with a focus on infrastructure scalability, mitigating the grid impact, managing traffic, and leveraging RES; facilitating the cross-border services for and from electricity consumers, like automated switching of energy supplier at cross-border level, joining virtual energy communities;
hybridisation of energy sources for data centres; drone- and AI-based services to increase the security and efficiency of ports operations; streamlining of inspection permits for linear infrastructures with drones; and green blockchain platforms to quantify the carbon footprint of goods and people between ports and support the decision-making of international routes.

TECHNICAL DETAILS

CONSIDERATIONS ON GENERAL TECHNICAL REQUIREMENTS

An Operational Digital Platform (ODP) must be scalable, interoperable, secure, and reliable. Key features of an ODP include:

Scalability: Supports growth in users and data without compromising performance through efficient infrastructure.

Interoperability: Enables seamless integration and data exchange across diverse systems with standardized protocols.

Data Management: Handles data effectively, supporting analytics and insights critical for decision-making.

Data Security and Compliance: Ensures data confidentiality and regulatory compliance via encryption and access controls.

Reliability: Ensures uptime with redundancy and fault tolerance to meet performance standards. Standardization: Leverages open standards for interoperability, adaptability, and future-proofing.

CONSIDERATIONS ON GENERAL REGULATOR FRAMEWORK

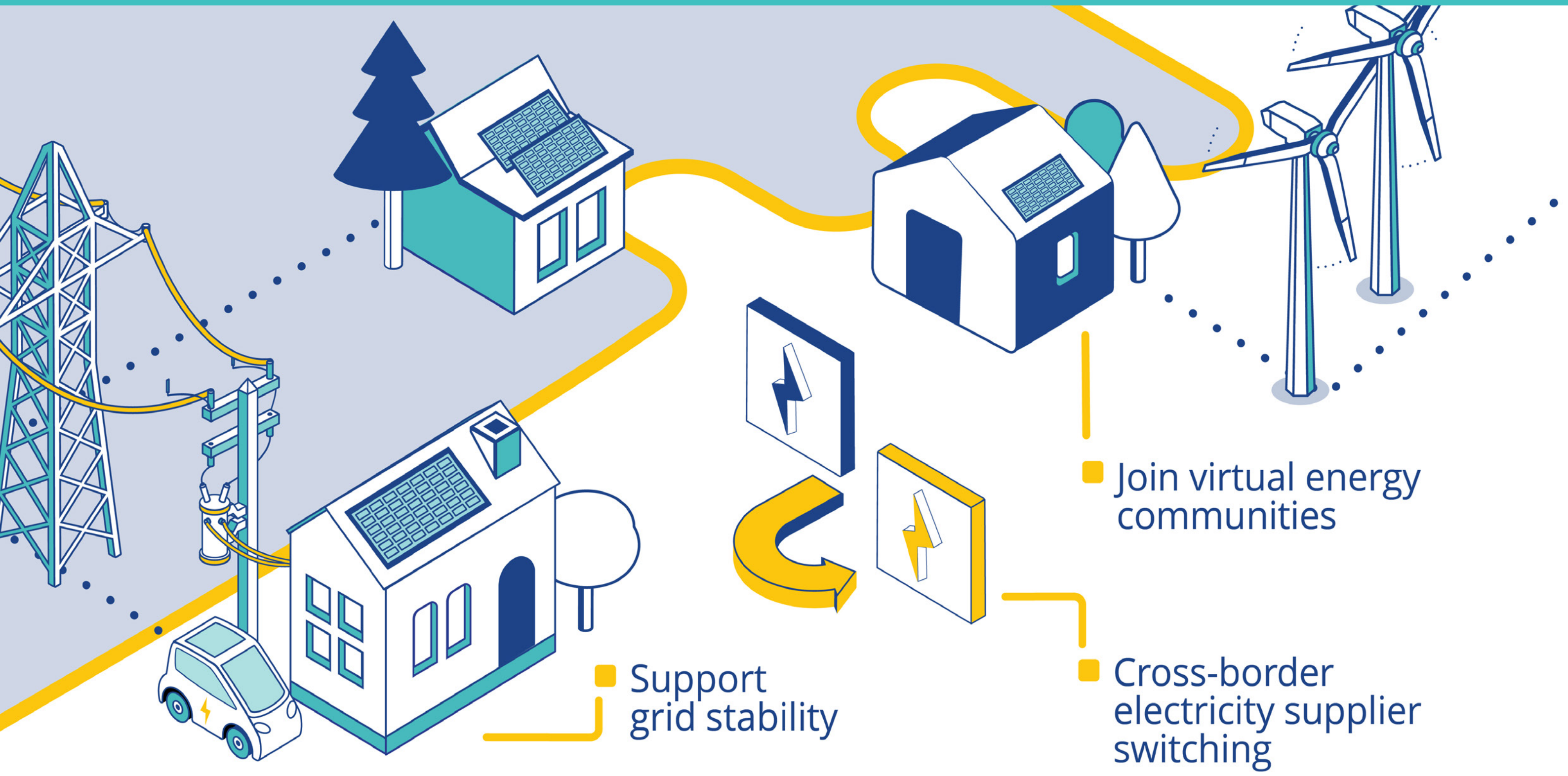
Each BEGONIA Use Case must align with applicable policies and technical standards. While the detailed regulatory framework will be developed in later project phases and varies for each UC, it consistently includes data-related policies alongside sector-specific regulations and directives for (according to the case) transport, electricity, and/or mobility, ranging from the Clean Energy Package, to the Digital Strategy, and the Alternative Fuels Infrastructure Regulation.

Nevertheless, all Use Cases foster support the EU's strategic goals of achieving climate targets, fostering digitalization and electrification, enhancing cross-border cooperation, and ensuring interoperability. This reflects the vision of the Draghi report, which promotes EU integration, the harmonization of decarbonisation and competitiveness and the acceleration of an affordable energy transition through smart grids and AI-driven energy management systems.

UC
I

ELECTRICITY CUSTOMER CENTRIC ODP

OWNER: DTU, BLUEPRINT ENERGY, AND OASC



TARGET COUNTRIES

• DENMARK • GERMANY • SWEDEN

MAIN FEATURES

• CROSS-BORDER • POWER TRANSMISSION AND DISTRIBUTION
• RENEWABLE ENERGY SUPPORT • BUSINESS • EDGE • CLOUD
• ENERGY EFFICIENCY

STAKEHOLDERS

• ELECTRICITY CUSTOMERS • RENEWABLE ENERGY SOURCES
• TRANSMISSION SYSTEM OPERATORS • EV OWNERS • RETAILERS
• AGGREGATORS

UC I

ELECTRICITY CUSTOMER CENTRIC ODP

OBJECTIVES

- Introducing a platform for delivering services to electricity customers that benefit both customers and all involved parties.
- Introducing a cross-border electricity supplier changing service that facilitates the interaction between the consumer, suppliers, and intermediate parties with minimal information exchange and a secure and fast customer verification process.
- Facilitate user involvement in renewable energy use, create virtual RES communities, and incentivize flexible, sustainable practices for energy consumers and EV owners.
- Enable local energy and flexibility trading, load aggregation for EU grid services, and grid vulnerability analysis to support grid stability.

CHALLENGES

- Interoperability between different components of the platform.
- Policies for the participation of demand side and aggregators in grid markets.
- Defining mechanisms for baseline estimation and measuring demand-side and aggregators flexibility.
- Affordable hardware and software tools for controllable loads to interact with the platform.
- Automate iterative documentation flow and conflict resolution among stakeholders in the electricity supplier change process.

SCOPE

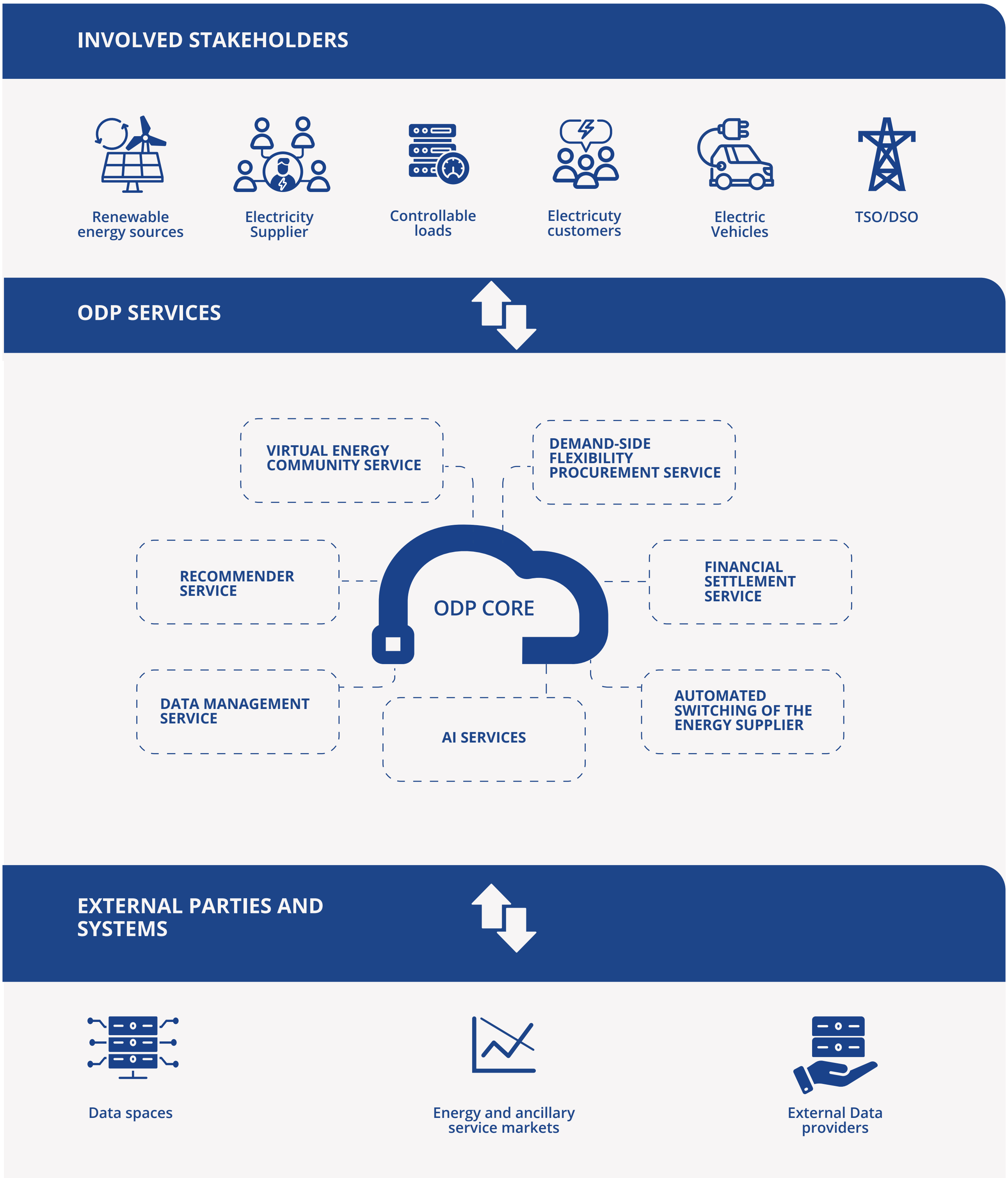
This use case introduces a platform for facilitating cross-border services for and from electricity consumers. By joining the platform, consumers will receive services such as automated switching of energy suppliers at a cross-border level, joining virtual energy communities, playing a role in the green transition, providing grid services, supporting grid stability and earning money, and receiving recommendations for reducing the risk of power cuts.

On the other hand, they will support the distribution and transmission grids and RESs. The customers will be allowed to interact with the platform both autonomously (connecting controllable devices to the platform while ensuring the satisfaction of their comfort limitations) and manually (via mobile apps by receiving notifications and reacting accordingly). AI approaches will play a key role in different services for forecasting and decision-making under uncertainty. The platform will also allow EV owners to identify charging points supplied by RESs and charge EVs with clean energy.

UC I

ELECTRICITY CUSTOMER CENTRIC ODP

DIAGRAM



UC I

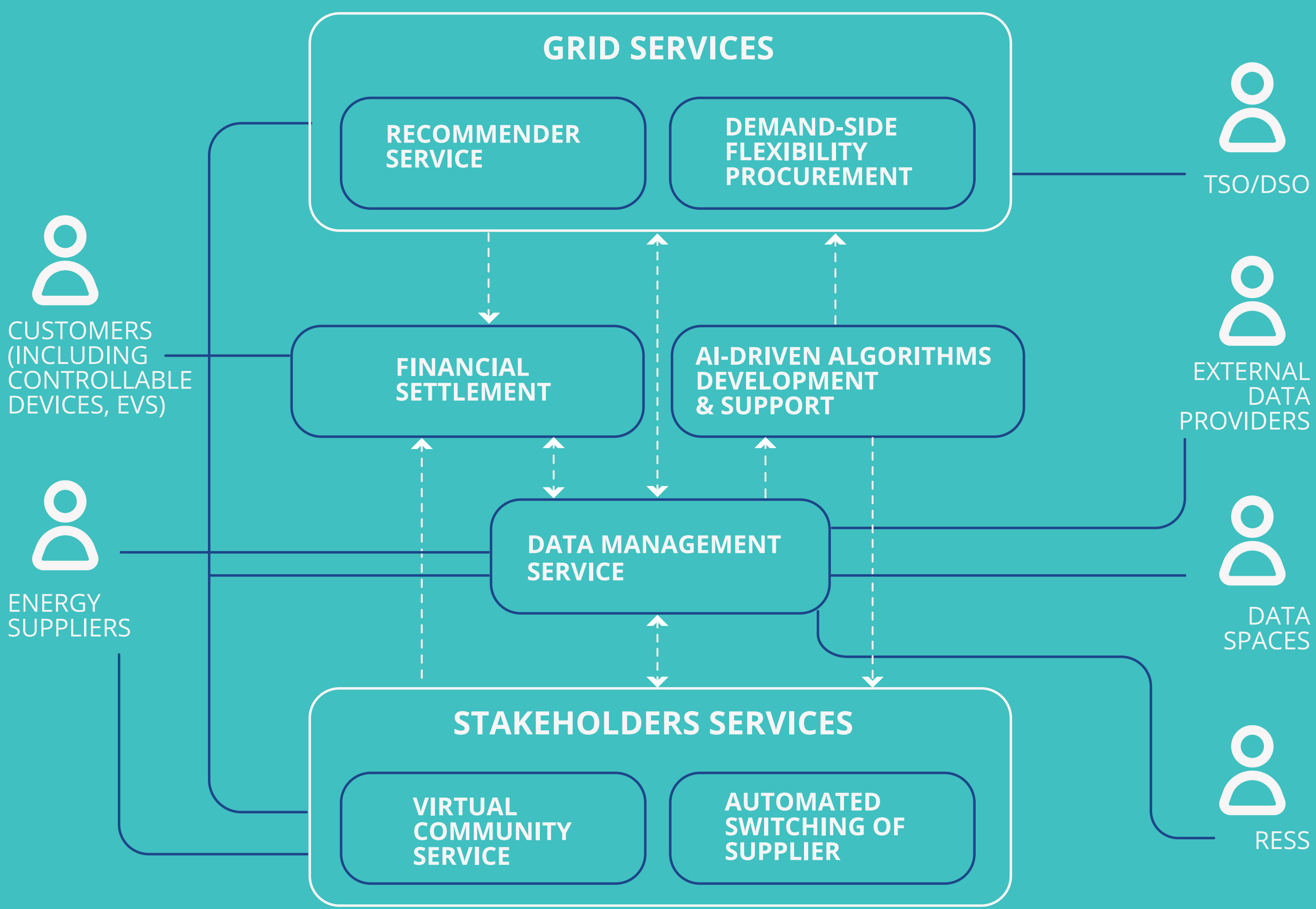
ELECTRICITY CUSTOMER CENTRIC ODP

ODP BUSINESS BENEFITS POTENTIAL

The platform benefits all involved stakeholders. Facilitating the cross-border change of suppliers, gives customers more options and more innovative services and opens new markets for suppliers.

Participating in grid services reduces customers' electricity bills and supports RESs while helping the TSOs to achieve grid stability. Virtual communities benefit RESs with fewer power cuts and customers with reduced costs.

PLATFORM BOUNDARY



ELECTRICITY CUSTOMER CENTRIC ODP

OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

Data is the key element in developing AI-driven services and other services such as financial settlements. So, data collection, management and processing mechanisms are required. Smart meters should be installed at customers, RESs, and grids levels for collecting and sending data to the databases.
These data and other required data for the platform must be accessible via data space framework or other defined frameworks in the platform.
Artificial Intelligence is vital for forecasting, grid vulnerability analysis, and automated trading. AI-based tools should be developed to facilitate the use of AI in the platform. In cross-border supplier change service, a standard framework should be defined for terminating and initiating contracts considering regulations at different member states. Frameworks should be defined for autonomous interaction of controllable loads, RESs and platform services. Additionally, algorithms and tools should be developed for each of the main services of the platform.

FULL NARRATIVE

The EU aims for climate neutrality by 2050 [2]. While renewable energy sources are crucial to this goal, their unpredictability requires innovative solutions to maintain grid stability. Demand-side flexibility is known as a promising solution for grid issues. Since the power grids of all EU member states are interconnected, operational issues in one country can quickly impact others.
Thus, effective solutions must be both cross-border and adaptable to differing national regulations on demand flexibility.

In this use case, an ODP is proposed to provide cross-border services for electricity end-users that benefits all involved stakeholders including end-users, suppliers (retailers), RESs, TSOs, and DSOs.

The ODP will register various RESs, such as solar and wind, along with controllable loads like EV charging points, batteries, and HVAC systems. These devices consume significant amount of energy and are equipped with smart controllers that are capable of interacting with ODP.

The main services defined for the platform are the virtual energy community services, a recommender service to predict grid vulnerabilities and reacting, demand-side flexibility procurement service, and cross border change of supplier for end-users.

UC
I

ELECTRICITY CUSTOMER CENTRIC ODP

In addition, a data management service is defined to manage all activities around data collection, communication, processing, and storage, and interacting with data spaces. AI services are considered to develop required AI-driven algorithms for the ODP. Finally, a financial settlement service is used to collect all the related information from different services and calculate the final bills for involved stakeholders.

SCENARIOS

- **Virtual Energy Community:** RESs and controllable devices can form a community in which end-users are supplied by RESs and demand side flexibility is used to cover RESs uncertainties.

- **Green energy options for EVs:** EVs are informed about charging points with clean energy.

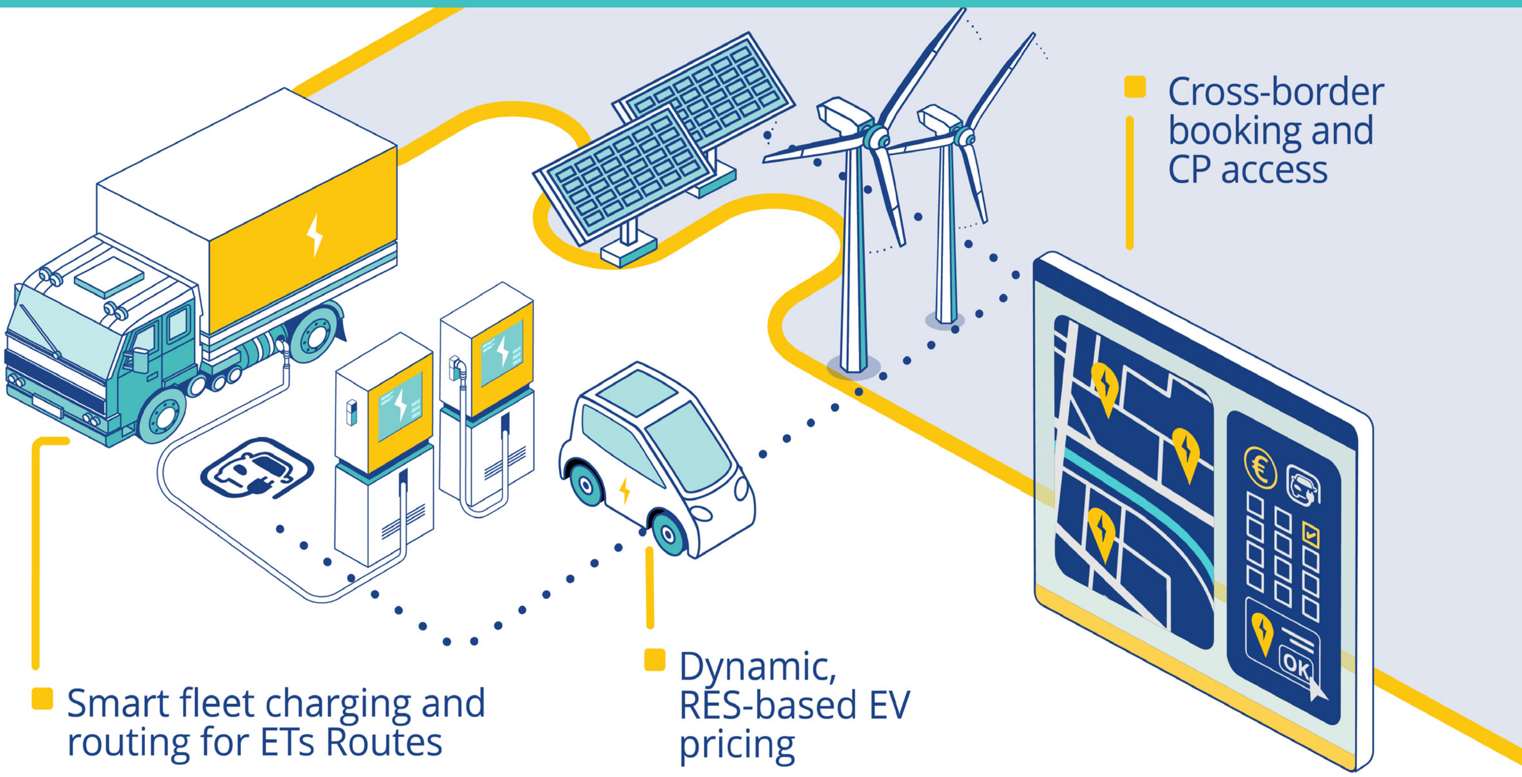
- **Recommender and Flexibility Services:** Grid vulnerability is predicted and notifications are sent to end-users. Additionally, demand-side flexibility is used for grid stability.

- **Automated Supplier Switching:** End-user can use a unified system for 24-hour supplier switching at cross-border level.

UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

OWNER: BLUEPRINT ENERGY SOLUTIONS



TARGET COUNTRIES

- AUSTRIA
- HUNGARY
- SLOVENIA

MAIN FEATURES

- EV CHARGING
- RENEWABLE ENERGY TRADING
- GRID SERVICES

STAKEHOLDERS

- EV CHARGING POINTS
- RESs
- EV OWNERS
- TSO
- DSO
- ET OWNER COMPANIES

UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

OBJECTIVES

- Propose a digital platform that facilitates the coordination of EVs (including private EVs and Electric Trucks -ETs- owned by companies), RES, and grid services.
- Develop weather-based AI methods to predict future production levels of RES.
- Implement dynamic pricing models based on the availability of RESs and grid status to make EV charging more affordable and promote greater adoption of EVs.
- Crafting adaptive charging coordination frameworks that adjust to real-time grid conditions and renewable energy availability, optimizing charging schedules based on data-driven insights.
- Provide Charge Point (CP) booking and routing services for EVs.
- Providing charging coordination services for companies that own ETs and CPs, considering the level of access to data and control.

CHALLENGES

• Complexity of underlying factors (weather patterns, traffic patterns, and user behavior). • Building and maintaining infrastructure for cross-border EV charging, requires significant investment. • Regulatory barriers related to data sharing. • Fragmented nature of the EV charging market.

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, managing traffic, and leveraging RESs. The platform aims to provide various services to different types of EVs including private EVs or electric trucks in a cross-border manner.

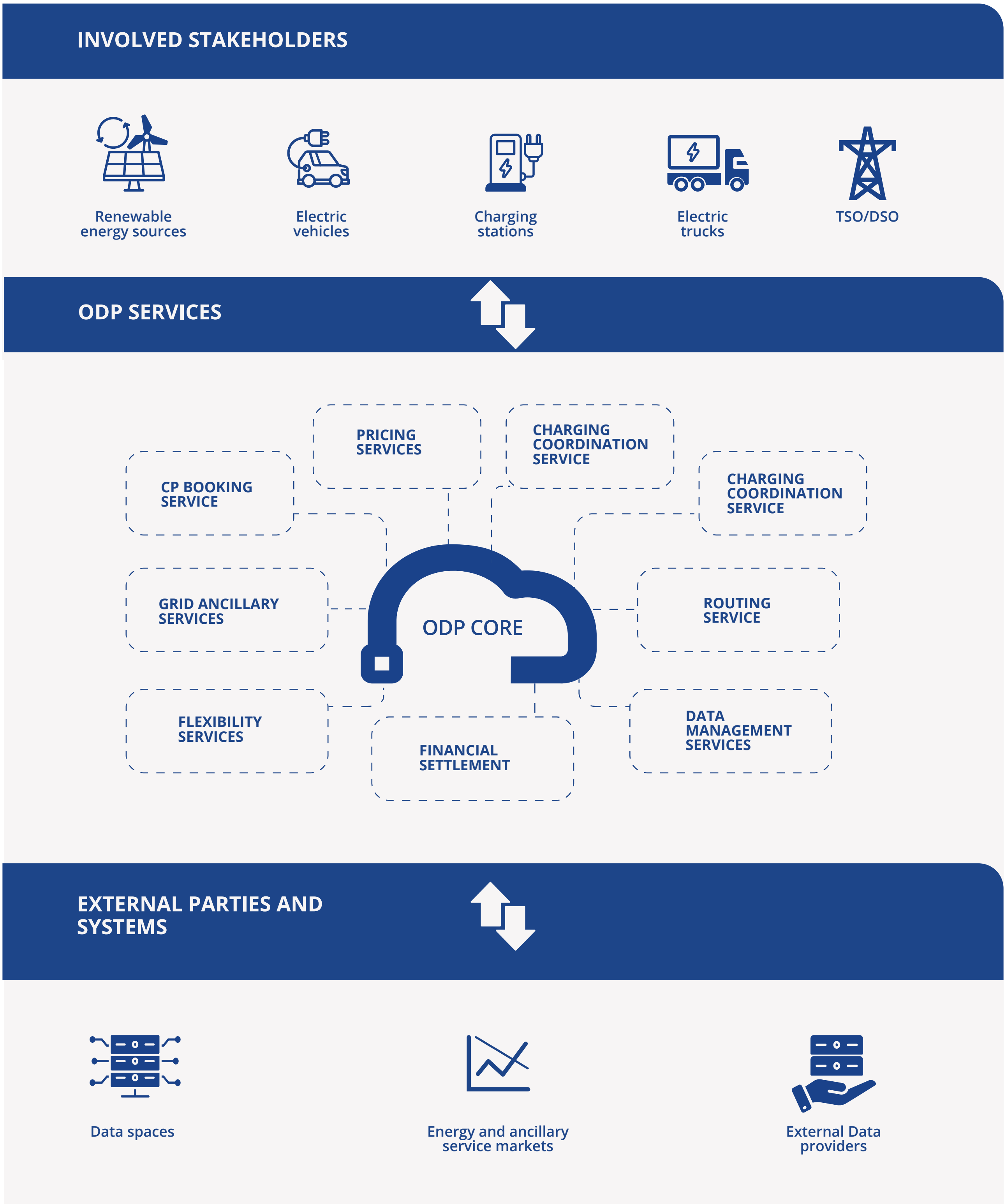
The services could be charging point booking, dynamic pricing for supporting RESs, charging coordination considering grid and users' requirements, routing, and grid ancillary services.

There will also be specific services for ET owner companies for routing and charging scheduling of a fleet of ETs considering fairness among different companies. Using AI the behavior patterns of EV and ET users are identified using historical data, RES production is forecasted, the dynamic prices for incentivizing EVs to support RESs and mitigate grid issues are generated, and optimal charging coordination strategy and routing plan is obtained.

UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

DIAGRAM



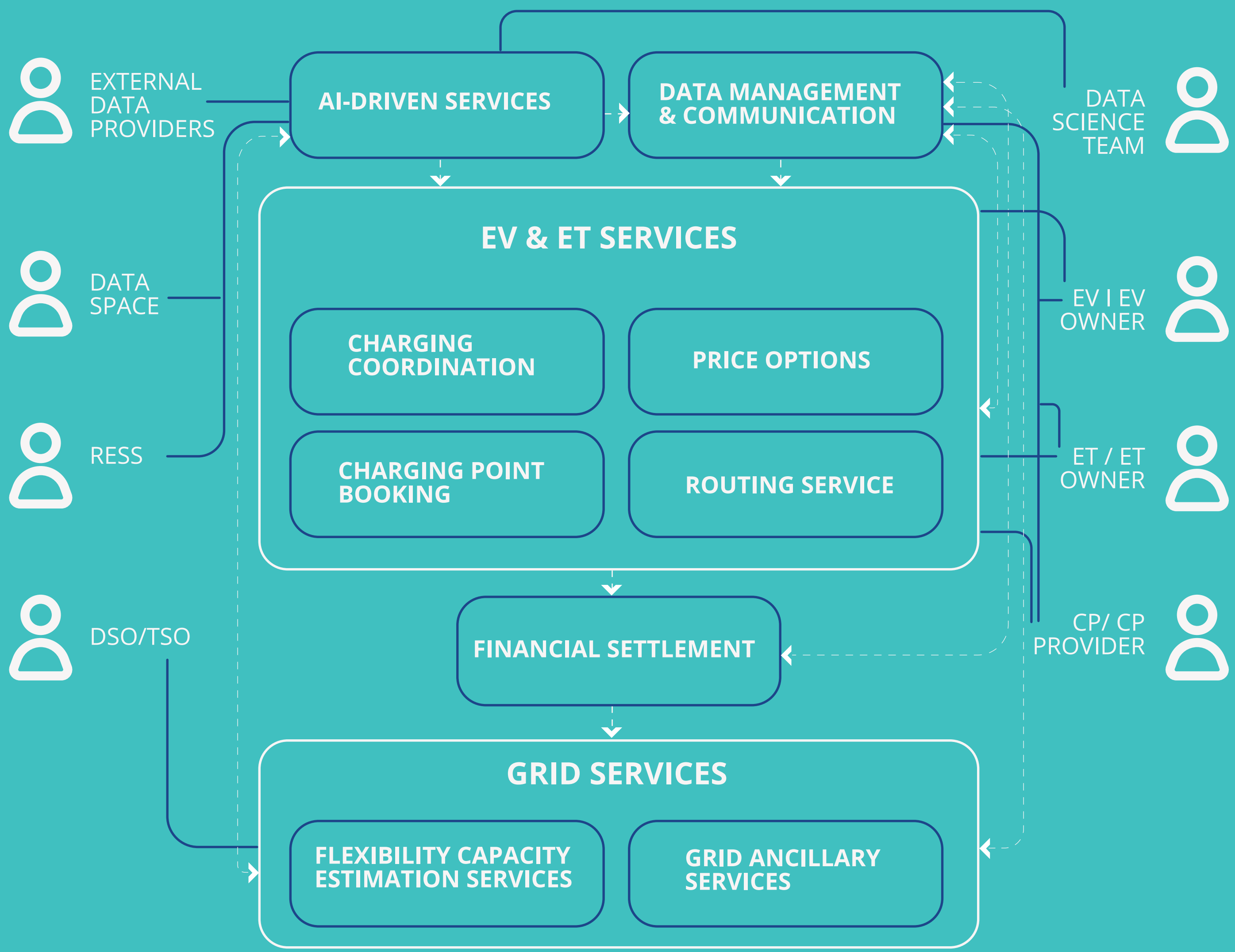
UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

ODP BUSINESS BENEFITS POTENTIAL

The charging station booking and routing services can help for more comfortable use of EVs and reduce the travelling time. Different price options are suggested to change the EV drivers' behavior for supporting RES and reducing the stress on the distribution grids. Grid flexibility services are defined to utilize the flexibility of EVs and ETs for balancing services.

PLATFORM BOUNDARY



UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

An energy data space will be established to enable secure and interoperable sharing of data among stakeholders, including energy providers, charging stations, and renewable energy sources (RES). This data space will facilitate access to real-time and historical data on energy production, grid load, and consumption, ensuring effective grid balancing and demand response. Smart meters and IoT sensors will collect granular data such as energy usage, voltage, and current for real-time analysis. Additionally, a mobility data space will provide seamless integration of data related to EV charging, including real-time SOC, booking schedules, and charging forecasts. These data spaces, powered by AI, will enable dynamic pricing models and trading of predicted and real-time energy demand, promoting efficient EV charging and grid optimization. The ODP integrates these technologies, providing a centralized platform for dynamic pricing, grid balancing, EV routing, and seamless stakeholder collaboration.

FULL NARRATIVE

Transportation is the fastest-growing source of emissions worldwide and now accounts for 14 percent of GHG emissions [3]. In this regard, achieving the long-term transition to a low-carbon European economy requires special attention to the electrification of the transport sector.

In 2023, 3 million EVs were sold in Europe which shows an exponential growth during the years [4]. Among different types of transportation systems, medium and heavy trucks are the sources of 22% of GHG emissions [5]. Considering that a growing percentage of this cross-border commuting is done by EVs and ETs, this cross-border commuting necessitates a cross-region, bilateral infrastructure to support the daily routines of commuters in terms of transportation [6].

This poses several challenges including the increased demand put on the distribution grids at different member states. Considering all these aspects, this use case aims to propose an ODP that facilitates electric mobility and supports RESs and the grid.

Charging station booking and routing services are proposed to help for more comfortable use of EVs and reducing the travelling time. Different price options are suggested including a dynamic pricing method affected by RES generation that is used to change the EV drivers' behavior for supporting RES and reducing the stress on the distribution grids.

UC II

AI-DRIVEN ODP FOR INTEGRATION OF EVS, ETS, RES AND GRID

Additionally, grid flexibility services are defined to utilize the flexibility of EVs and ETs for balancing services. The platform will be designed in such a way as to facilitate data communication between different technologies, data spaces, and the ODP.

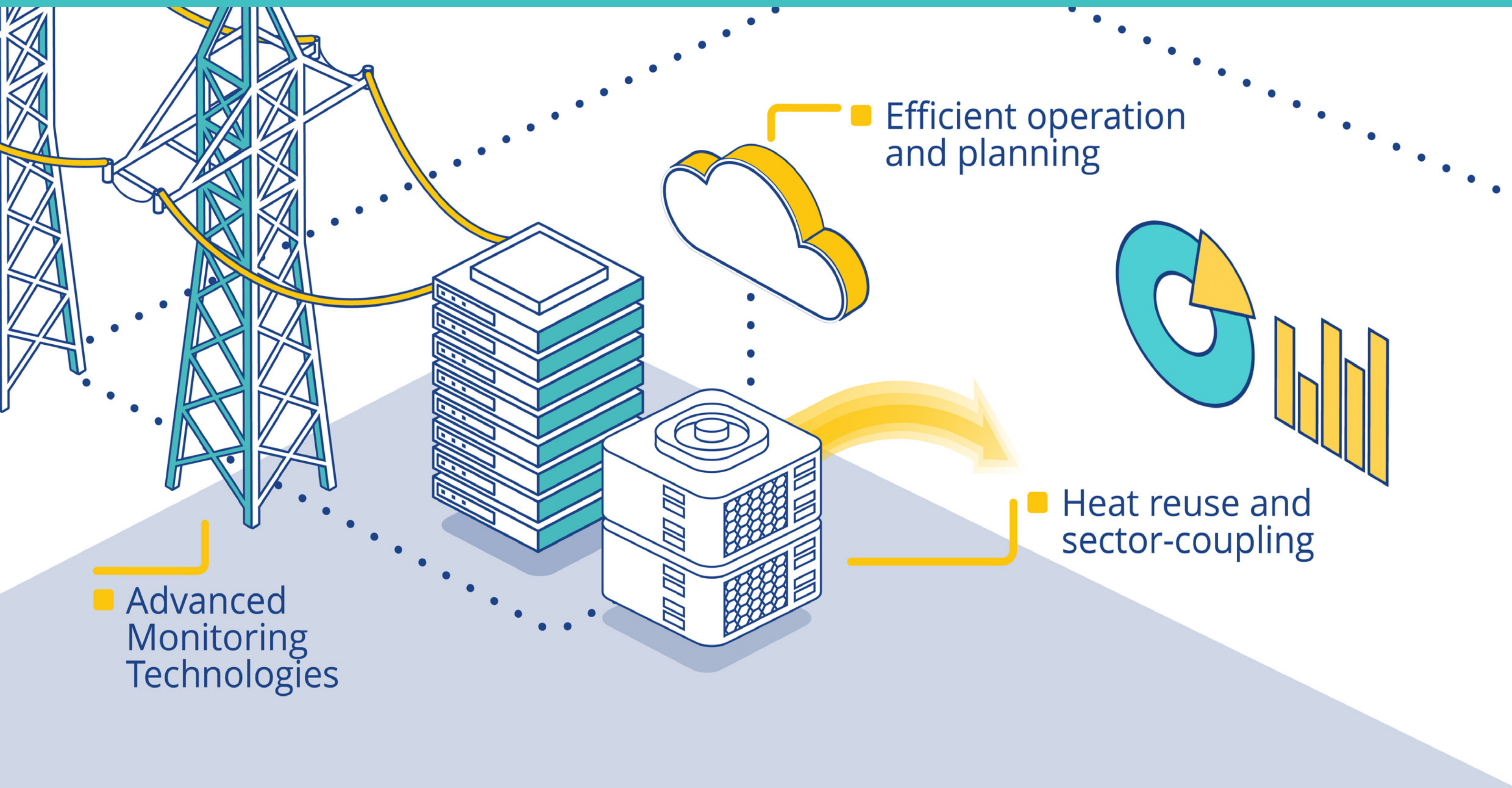
SCENARIOS

- Real-time data collection
- Federated model update
- Enforcing regulatory, security, sovereignty and compliance requirements on the EU- and member state- level
- AI-based energy production and consumption prediction
- Dynamic energy pricing
- Real-time analysis
- Grid ancillary services
- EV charging network expansion.

UC III

DIGITALIZATION OF DATA CENTERS

OWNER: TECHNICAL UNIVERSITY OF DENMARK



TARGET COUNTRIES

- SWEDEN
- DENMARK
- GERMANY

MAIN FEATURES

- CROSS BORDER
- EDGE
- SECTOR COUPLING
- ENERGY
- GENERATIVE AI

STAKEHOLDERS

- DATA CENTER OPERATORS
- TRANSMISSION SYSTEM OPERATORS
- DISTRIBUTION SYSTEM OPERATORS
- DISTRICT HEATING & FUEL COMPANIES

UC III

DIGITALIZATION OF DATA CENTERS

OBJECTIVES

- Monitoring, operation, and planning of cost-effective operation of Data Centers (DCs) considering combinations of heat, cool, electricity storage technologies and RESs.
- Real-time cross-border load rescheduling for mitigating Generative AI (GAI) load impact on the electrical system and providing grid/ancillary services.
- Innovation of DCs' cooling systems, e. g. using liquid cooling.
- More informed contracts between DCs, TSOs and district heating and fuel companies for provision of ancillary services increasing profitability and sustainability of their business.

CHALLENGES

- Integration of proposed IoT-based solutions with existing Scada systems.
- Time required for building sector interfaces (e. g. with fuel pipelines).
- Regulations outside Denmark concerning waiver of PPOs for local flexibility services.

SCOPE

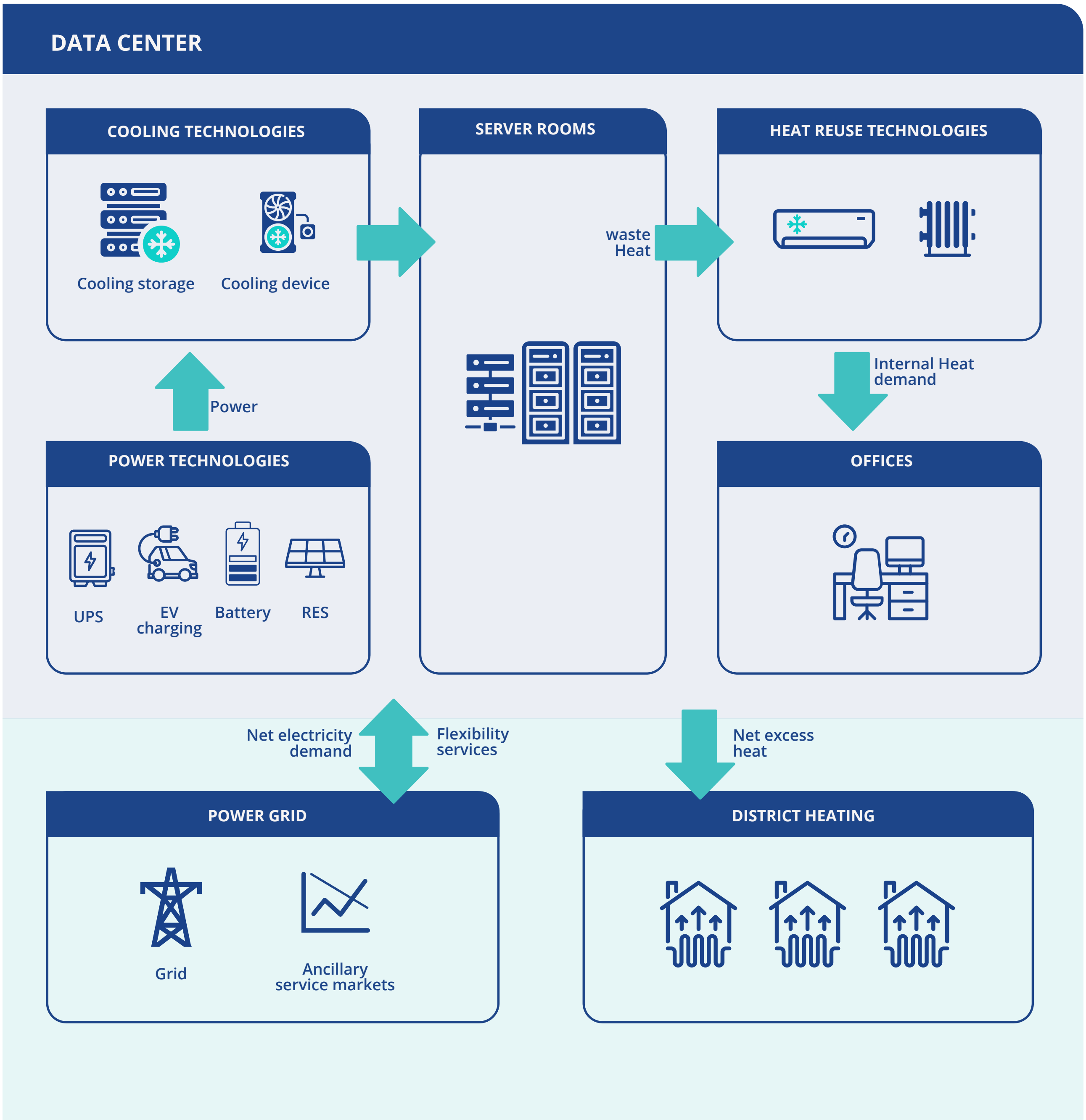
This use case proposes an Operational Digital Platform (ODP) that enables Data Centers to operate as cross-sector prosumers in the EU-scale energy and support transmission networks by providing ancillary services, moving their compute loads across the border and planning for innovative equipment integration based on real-time energy analytics.

The business case proposed for the DC industry is to cope with the increasing AI demand [7] and curb Moore's law while keeping their KPIs at their superior level by utilizing sustainability enablers, e. g. renewable energy resources (RES), controllable loads (CL), emerging energy reuse/conversion technologies, digital interfaces and IoT.

The ODP relies on digital twins and energy management techniques operating on the digitalized infrastructure. It promotes the DC-specific aggregators across member states to address increasing GAI loads and enable integration of EU electricity markets.

DIGITALIZATION OF DATA CENTERS

DIAGRAM



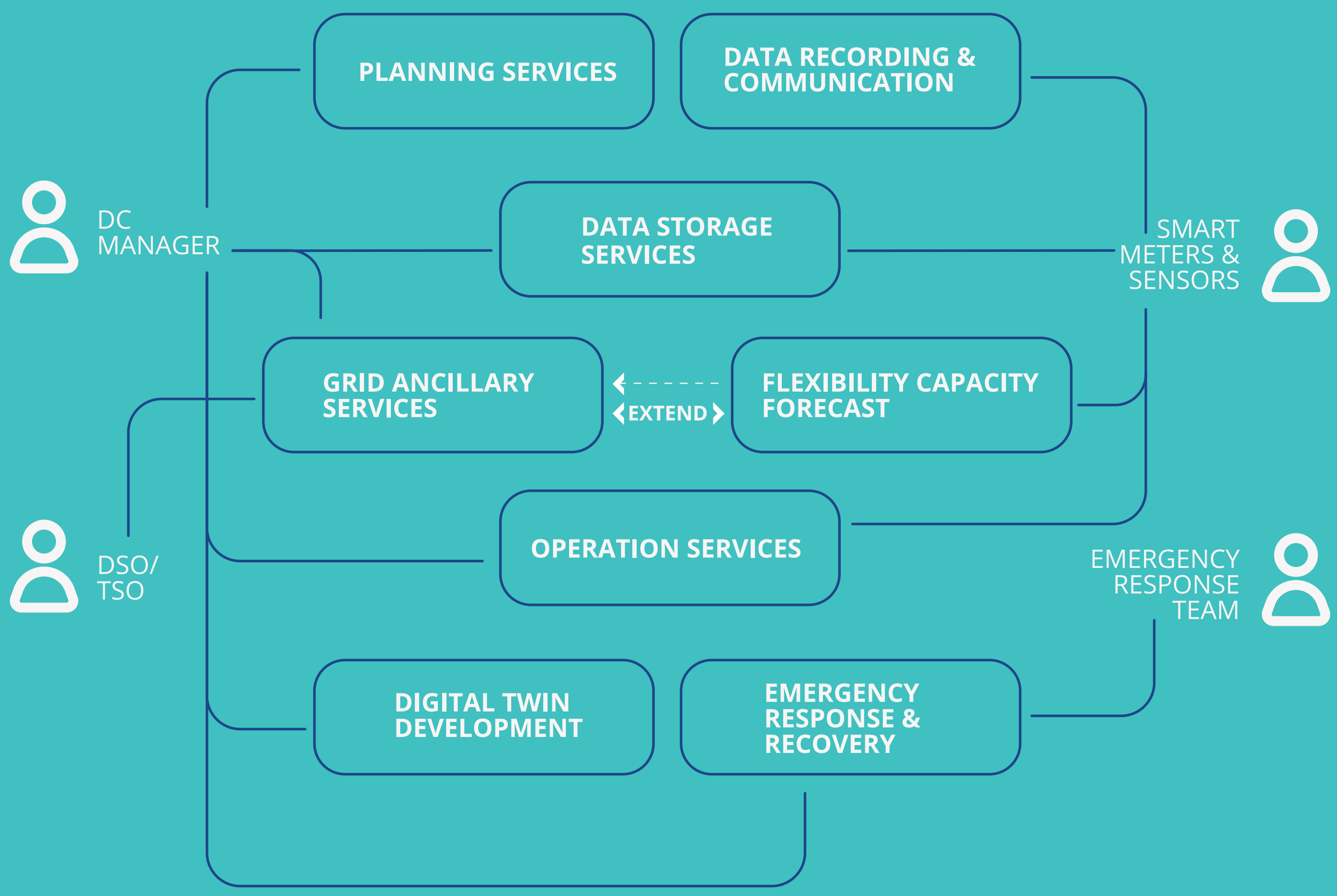
UC III

DIGITALIZATION OF DATA CENTERS

ODP BUSINESS BENEFITS POTENTIAL

1. Real-time equipment integration planning, load rescheduling will help optimize investment costs associated with infrastructure renovation necessary under surging AI loads.
2. Dynamic flexibility estimation across sectors will identify revenue streams under environmental regulations incentivising sustainability in DCs.
3. Real-time coordination of cross-border energy/data transport between DCs will mitigate the impact of Generative AI and High-Performance Computing (HPC) loads on the European grid.

PLATFORM BOUNDARY



OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

Sensor technologies, IoT connectivity, and databases are needed to measure, communicate, and store, temperature, power, and compute load. Also, in the case of providing grid and heating services, tools are needed for interaction with TSO or the district heating network.

Tools and technologies are required for developing the DC digital twin including AI and machine learning tools for modeling, optimization, and control, simulation tools for creating physics-based simulations of DCs' energy systems, and IoT integration tools to connect digital twins with real-world IoT sensor data. Additionally, existing digital twin frameworks such as Azure Digital Twins or AWS IoT TwinMaker can be used in this regard.

AI-driven tools will be developed to predict different parameters such as temperature, renewable energy production, and GAI load.
Orchestration and Workload Management frameworks can be used for orchestrating compute workloads across regions and borders.

FULL NARRATIVE

DCs are considered major future electricity consumers and producers of heat from server cooling due to surging GAI and HPC skyrocketing the power density (at around 100 kW/rack). On another end, recent regulations incentivise owners to equip DCs with sustainable technologies, e. g. renewable energy sources, green gas, Power-to-X conversion, advanced energy storage, fuel transport and heat reuse.

This increases DCs flexible capacity and requires new energy management techniques, e. g. sharing of computational load between DCs nationally and across member states.

This use case proposes an ODP that will provide services for planning, monitoring and managing new technologies in DCs across EU to stay sustainable and efficient. It enables aggregation, analysis and procurement of the multi-energy flexibility of DCs operations in different EU states to help DCs and TSOs cope with boosting AI loads.

UC III DIGITALIZATION OF DATA CENTERS

The proposed services cover:

- **Monitoring/planning:** digital twin-assisted investment assessment under technology integration and replacement.
- **Peak load management:** HPC and AI workloads planned as a higher “bids” and RES assets, respectively, in the cross-border power exchange.
- **Localization service:** Virtualization and moving AI and HPC workloads between locations.
- **Operation service:** Accepts and sends pretrained models from/to Data Spaces, status of different devices, Federated Learning retrains the models and schedules the operation of devices considering technical and reliability constraints.
- **Grid flexibility/ancillary service:** Forecasting and coordination of aggregated national flexibilities based on Federated Learning.
- **Emergency response and recovery:** On the UPS level, critical components, like network and storage servers, will be protected.

SCENARIOS

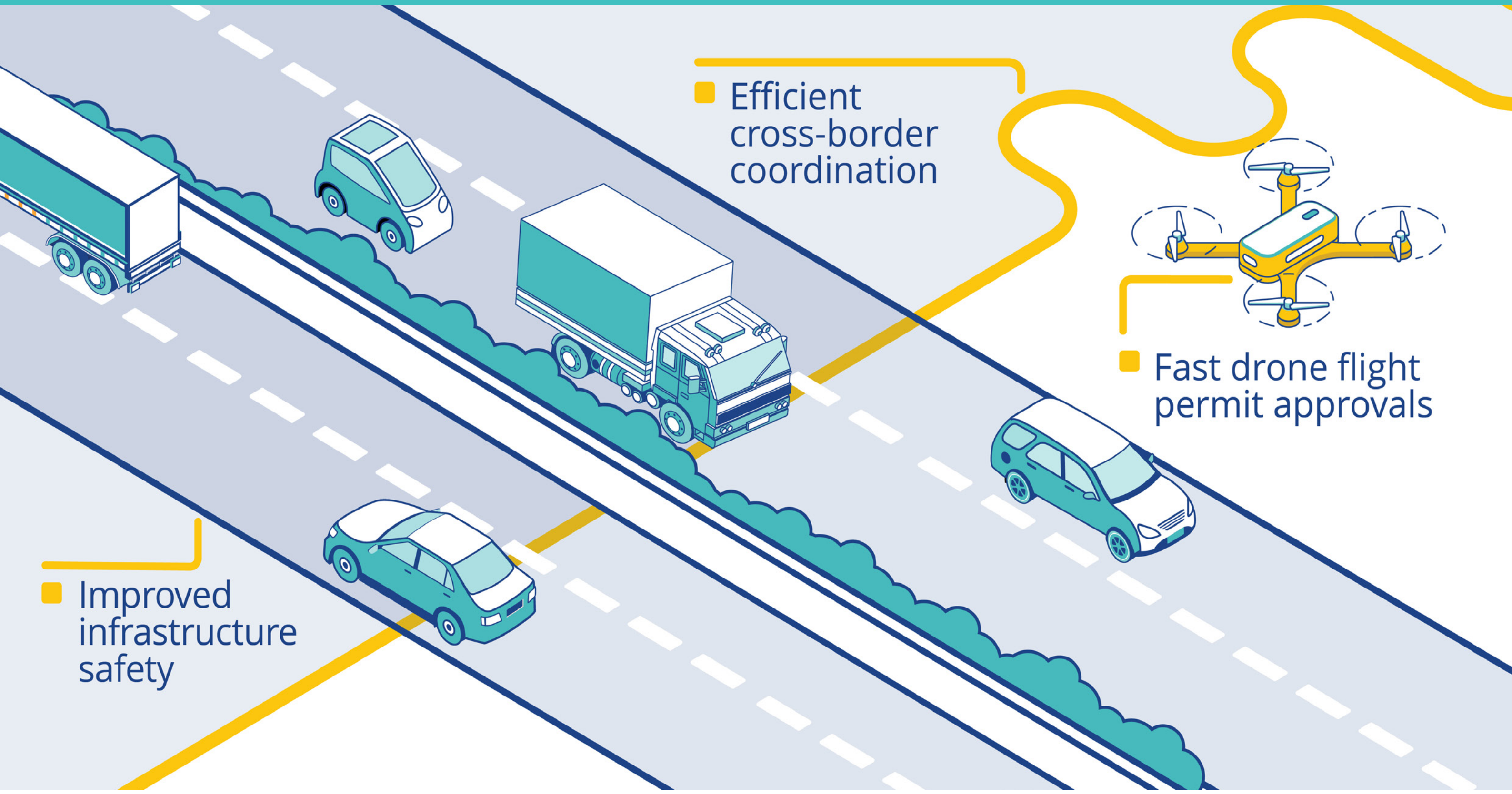
Planning: Parameters of the heat pump, water tank and battery storage are chosen from several options based on technoeconomic analysis of demand response scenarios inside the target DC.

Grid flexibility provision: The DC manager offers the flexibility capacity to the DSO/TSO taking into account the optimized forecast generated by an ODP, procuring flexible assets when requested by the DSO/TSO.

Localization: Jobs rescheduled automatically between DCs in several member states from monitoring service report about available server load capacities.

UC IV DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

OWNER: SPANISH MINISTRY OF TRANSPORT



TARGET COUNTRIES

- SPAIN
- PORTUGAL

MAIN FEATURES

- CROSS BORDER
- INFRASTRUCTURES
- EDGE
- CLOUD
- TRAFFIC AND LOGISTIC

STAKEHOLDERS

- MAINTENANCE MANAGERS
- LINEAR INFRASTRUCTURE AUTHORITIES
- AIR TRAFFIC CONTROLLERS
- DRONE OPERATORS

UC IV DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

OBJECTIVES

- Reduction of the time needed to obtain a flight permit to perform linear infrastructure inspections with drones.
- Reducing the risk of human error in the drone flight validation process while ensuring compliance with all applicable regulations.
- Reduction of traffic disruptions or undesired effects during infrastructure inspections, ensuring road safety.
- Improved maintenance of linear infrastructure under cross-border conditions with more frequent and accurate inspections.

CHALLENGES

- Managing multi-level (EU, national, regional) and cross-border regulations.
- Aligning multiple agencies with varying criteria and responsibilities.
- Ensuring compliance while minimizing risk of manual errors.
- Implementing a secure green blockchain-based governance model across jurisdictions.

SCOPE

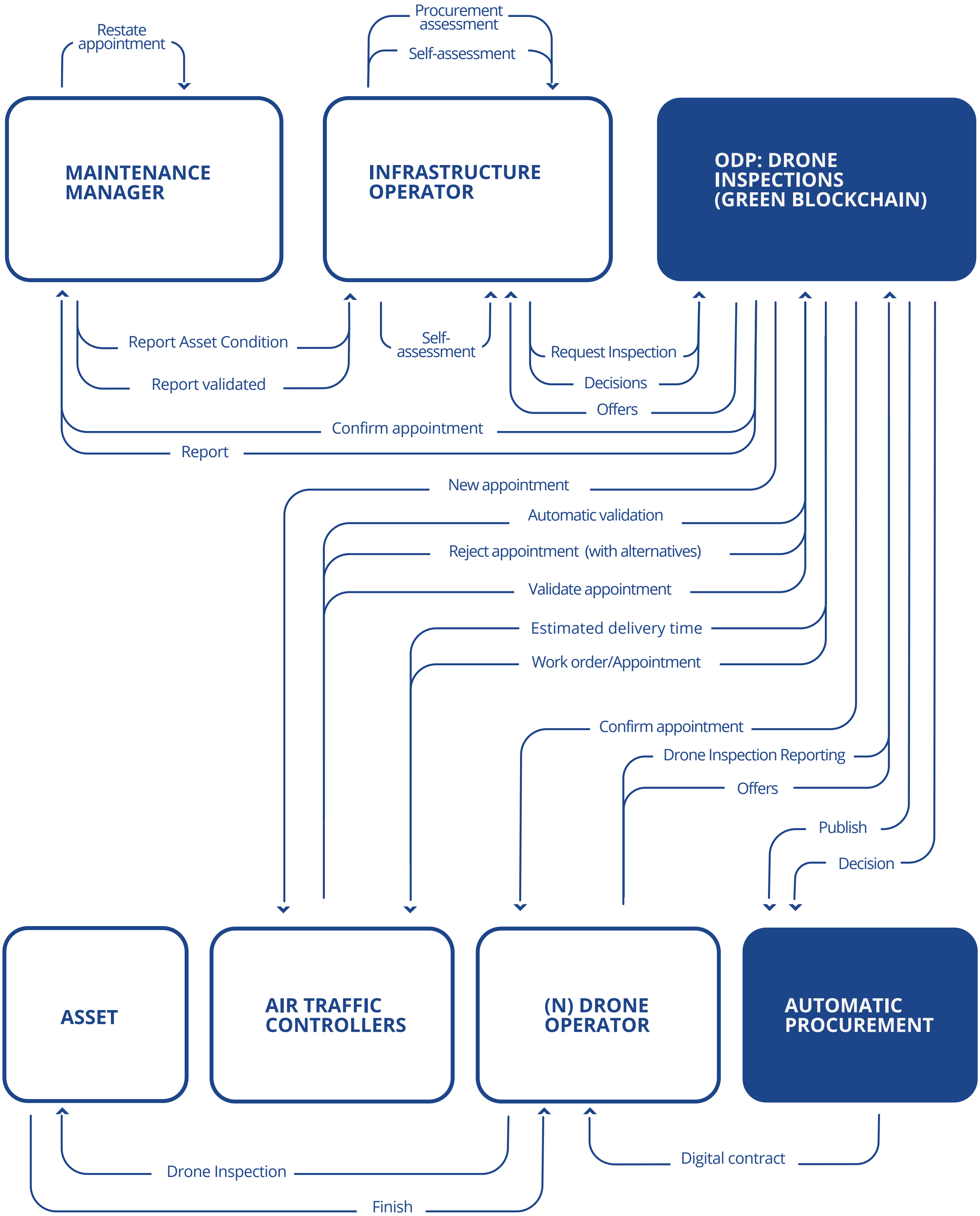
This UC aims to streamline the bureaucratic process of securing flight permits for drone inspections of linear infrastructure, such as roads, railways, and pipelines. Currently, obtaining these permits is time-consuming, involving multiple authorities across local, national, and cross-border levels.

This use case proposes a green blockchain-powered platform to connect air traffic controllers, regulatory bodies, and infrastructure managers, allowing them to coordinate permit issuance efficiently. By automating validation steps and consolidating approvals on a single platform, the ODP (Operational Digital Platform) would reduce waiting times, enhance safety, and enable more frequent, accurate inspections.

The system also supports cross-border operations, ensuring that all stakeholders are informed and compliant with local and international regulations, ultimately improving the maintenance and safety of critical infrastructure.

UC IV DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

DIAGRAM

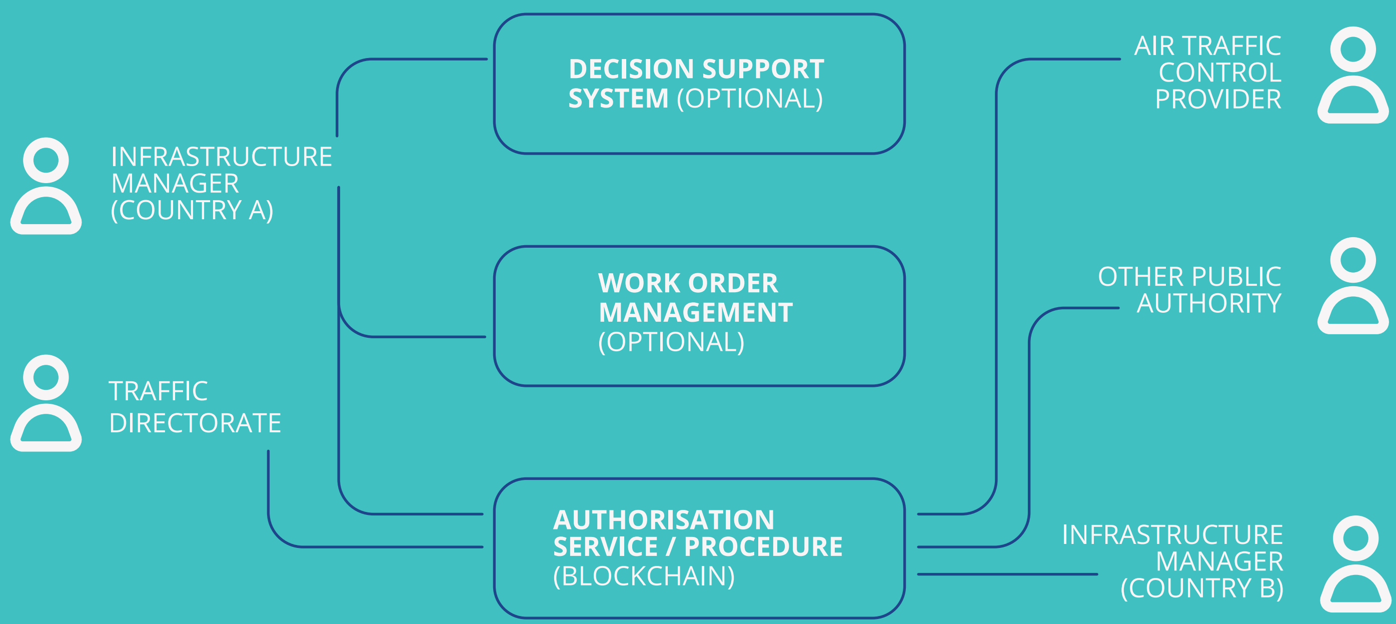


UC IV DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

ODP BUSINESS BENEFITS POTENTIAL

The ODP streamlines the permitting process for drone-based inspections in linear infrastructure, reducing the time and costs traditionally required for regulatory approvals. This efficient approach enables quicker, more frequent, and accurate inspections, improving regulatory compliance and reducing operational disruptions. By integrating all relevant authorities in a cross-border, blockchain-secured platform, the ODP enhances safety, supports sustainable infrastructure management, and provides substantial cost savings, setting a new standard for infrastructure maintenance.

PLATFORM BOUNDARY



UC IV DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

The ODP for drone-based inspections integrates advanced blockchain standards, edge computing, and cloud solutions to enable efficient cross-border permit validation. IEEE 3205-2023 [8] ensures blockchain interoperability, data authentication, and secure communication, while IEEE 3801-2022 [9] supports secure electronic contracts, enabling fast, compliant agreements across national borders.
The platform uses edge computing to process data near inspection sites, ensuring real-time validation and compliance checks, reducing latency, and enhancing responsiveness. Meanwhile, cloud infrastructure provides scalable data storage and centralized management, supporting coordination between stakeholders and aligning with diverse regional requirements in Spain, Portugal, and France.

FULL NARRATIVE

The Operational Digital Platform transforms the permitting process for drone-based inspections of linear infrastructure, making it faster, safer, and more compliant with complex regulations. While drones provide valuable, high-resolution data for infrastructure maintenance, regulatory approval is often slow due to multi-level authorizations required across national and regional bodies. The ODP addresses these delays by using blockchain and automation to securely connect all relevant authorities in a single platform, ensuring efficient, standardized permit validation.

Through edge computing, the platform processes data directly at inspection sites, enabling real-time compliance checks and reducing latency, while cloud infrastructure provides centralized data storage and coordination among stakeholders.

This combination allows seamless integration with air traffic control and regional authorities across cross-border regions like Spain, Portugal, and France, where differing regulations previously slowed operations. By reducing approval times from months to potentially days, the ODP lowers operational costs and facilitates routine drone inspections, making them a viable, sustainable option for maintaining infrastructure. This streamlined approach improves public safety and supports more frequent, accurate assessments of critical infrastructure assets.

UC IV

DIGITAL PERMITS FOR DRONE-BASED INSPECTIONS IN LINEAR INFRASTRUCTURES

SCENARIOS

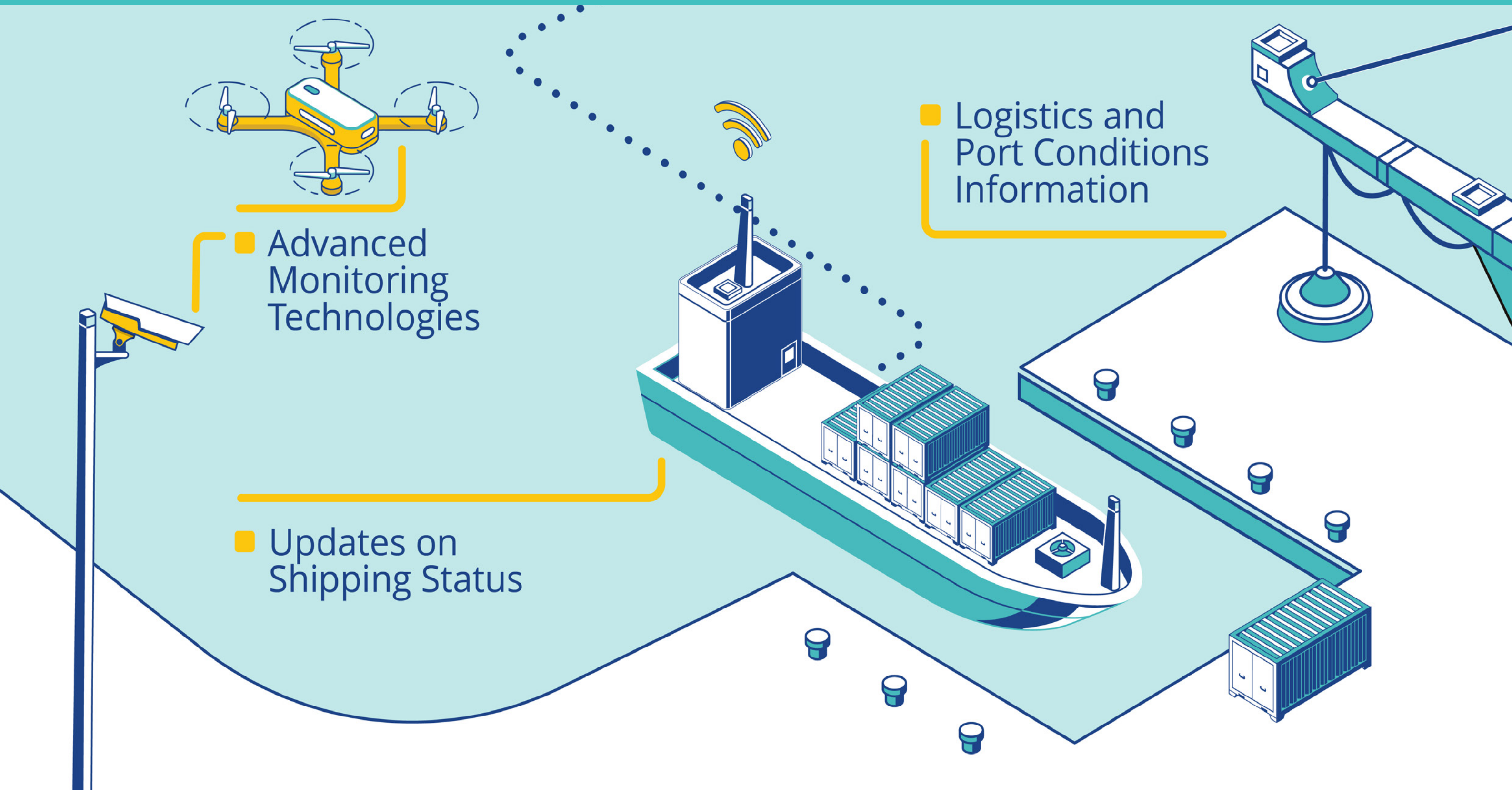
Routine Maintenance Inspections: Infrastructure managers initiate standard inspections using drones, with the ODP rapidly handling permit validations across multiple regulatory bodies.

Cross-Border Operations: For cross-national infrastructures, the ODP coordinates authorizations between national authorities, streamlining compliance for seamless, cross-border drone inspections.

SMART PORTS OPERATIONS

UC V

OWNER: AUTORIDAD PORTUARIA DE SEVILLA



TARGET COUNTRIES

• SPAIN • ANY OTHER PORT OR INLAND WATERWAY IN EUROPE

MAIN FEATURES

• CROSS-BORDER • OUTERMOST • TRAFFIC AND LOGISTICS • EDGE
•FOG • CLOUD • COMMUNICATION

STAKEHOLDERS

• PORT OPERATORS • SHIPPING COMPANIES •REGULATORY ENTITIES

UC V

SMART PORTS OPERATIONS

OBJECTIVES

- Monitor port operations in real-time through AI-driven cameras and drone systems.
- Ensure seamless integration of data into the port's FIWARE digital platform, enabling data analysis.
- Optimize resource allocation, scheduling and inventory management, promoting sustainable practices.
- Establish a scalable and replicable model for digital transformation in ports across Europe.

CHALLENGES

- Ensuring adherence to GDPR, aviation regulations for drones, and environmental standards.
- Achieving seamless data integration and compatibility between FIWARE and various digital platforms used by other ports.
- Upgrading and maintaining robust network connectivity, reliable power supplies, and sufficient data processing capabilities.
- Implementing strong cybersecurity protections.
- Reskilling and upskilling the port workforce to effectively manage and operate new technological systems.

SCOPE

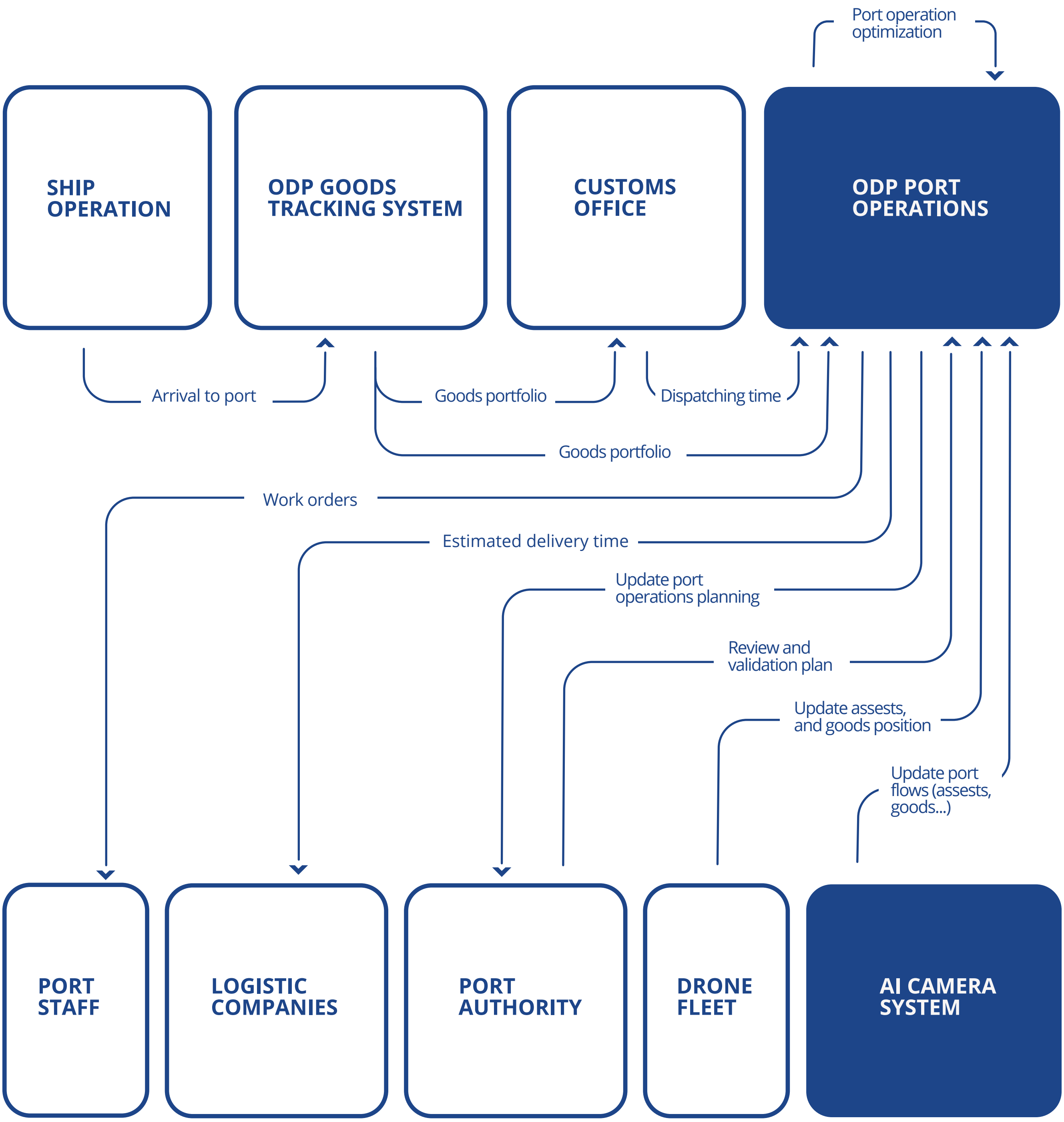
The Smart Port Operations Use Case aims to revolutionize port management by leveraging advanced digital technologies. This initiative integrates AI-driven cameras and drone systems to facilitate real-time monitoring of port activities, including the observation of docks, cranes, ships, and volumetric assessments of stockpiles. Central to this use case is the integration of the collected data into the port's FIWARE digital platform, which is endorsed by the CEF [10].
This integration not only aims to enhance operational efficiency but also focuses on improving safety and sustainability within port operations.

By providing comprehensive data analysis and visualization, the platform supports informed decision-making, optimizes resource allocation, and promotes effective scheduling and inventory management. The overarching goal is to establish a scalable and replicable model for digital transformation that can be adopted by other ports worldwide, fostering global collaboration and continuous improvement in smart port solutions.

UC V

SMART PORTS OPERATIONS

DIAGRAM



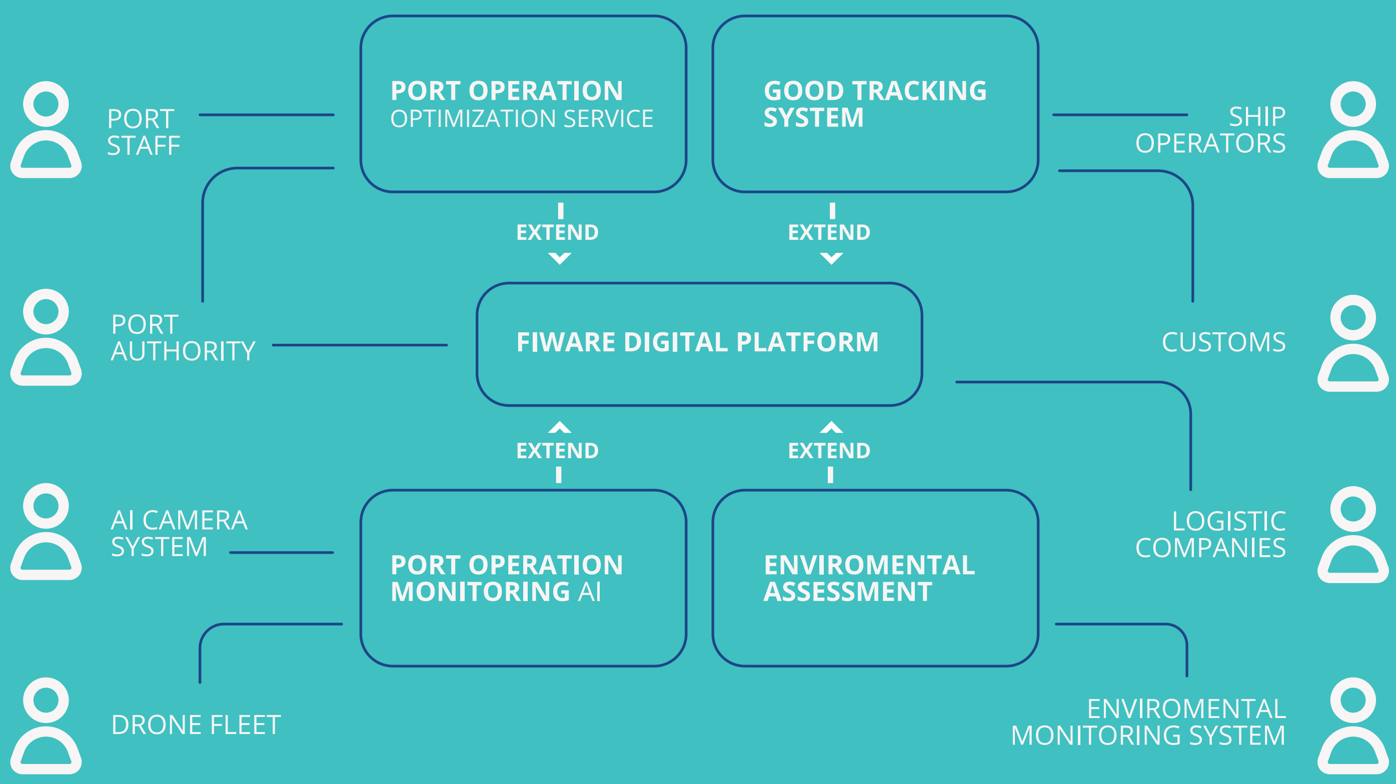
UC V

SMART PORTS OPERATIONS

ODP BUSINESS BENEFITS POTENTIAL

Utilizing advanced AI and drone technology, the platform ensures real-time monitoring and data integration, which optimizes resource allocation and decision-making. This scalability and improved data-driven management positions the ODP as a valuable tool for ports globally, promising substantial ROI through reduced operational costs and improved regulatory compliance.

PLATFORM BOUNDARY



UC V

SMART PORTS OPERATIONS

OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

The Use Case harnesses a suite of advanced technologies, frameworks, and tools to enhance port management efficiency and safety.
Central to this integration is the FIWARE digital platform, which facilitates the interoperability and real-time data processing capabilities.
AI cameras are deployed throughout the port to monitor vessel movements, cargo handling, and infrastructure conditions, providing continuous data feeds.
Drones equipped with high-resolution sensors complement this setup by performing aerial surveys, which are crucial for accurate and detailed inspections of hard-to-reach areas.
Data collected from AI cameras and drones is standardized and analyzed within FIWARE, enabling sophisticated visualization and predictive analytics. To ensure secure and reliable operations, the system incorporates robust cybersecurity measures, safeguarding against potential data breaches and ensuring compliance with GDPR.

FULL NARRATIVE

The Smart Port Operations Use Case is designed to transform port management through the strategic deployment of advanced monitoring technologies and a robust digital platform.
By utilizing AI-driven cameras and drone systems, the initiative provides real-time insights into various aspects of port operations, including the movement of vessels, the handling of cargo, and the condition of infrastructure.

These cameras are strategically positioned throughout the port to capture continuous data streams, while drones equipped with advanced sensors conduct daily reconnaissance missions, gathering detailed imagery to support precise resource allocation and infrastructure maintenance. The core of this digital transformation is the FIWARE digital platform, adopted by the CEF, which acts as a central hub for data integration and analysis.

This platform processes and visualizes the data collected, enabling port authorities and stakeholders to make informed decisions rapidly.
The integration of real-time data with FIWARE facilitates efficient resource management, enhances safety by providing insights into operational risks, and promotes sustainability through optimized scheduling and reduced environmental impact.

UC V

SMART PORTS OPERATIONS

Through this use case, ports are equipped to handle increased operational demands and complexities, ensuring smoother operations and contributing to global trade efficiency.

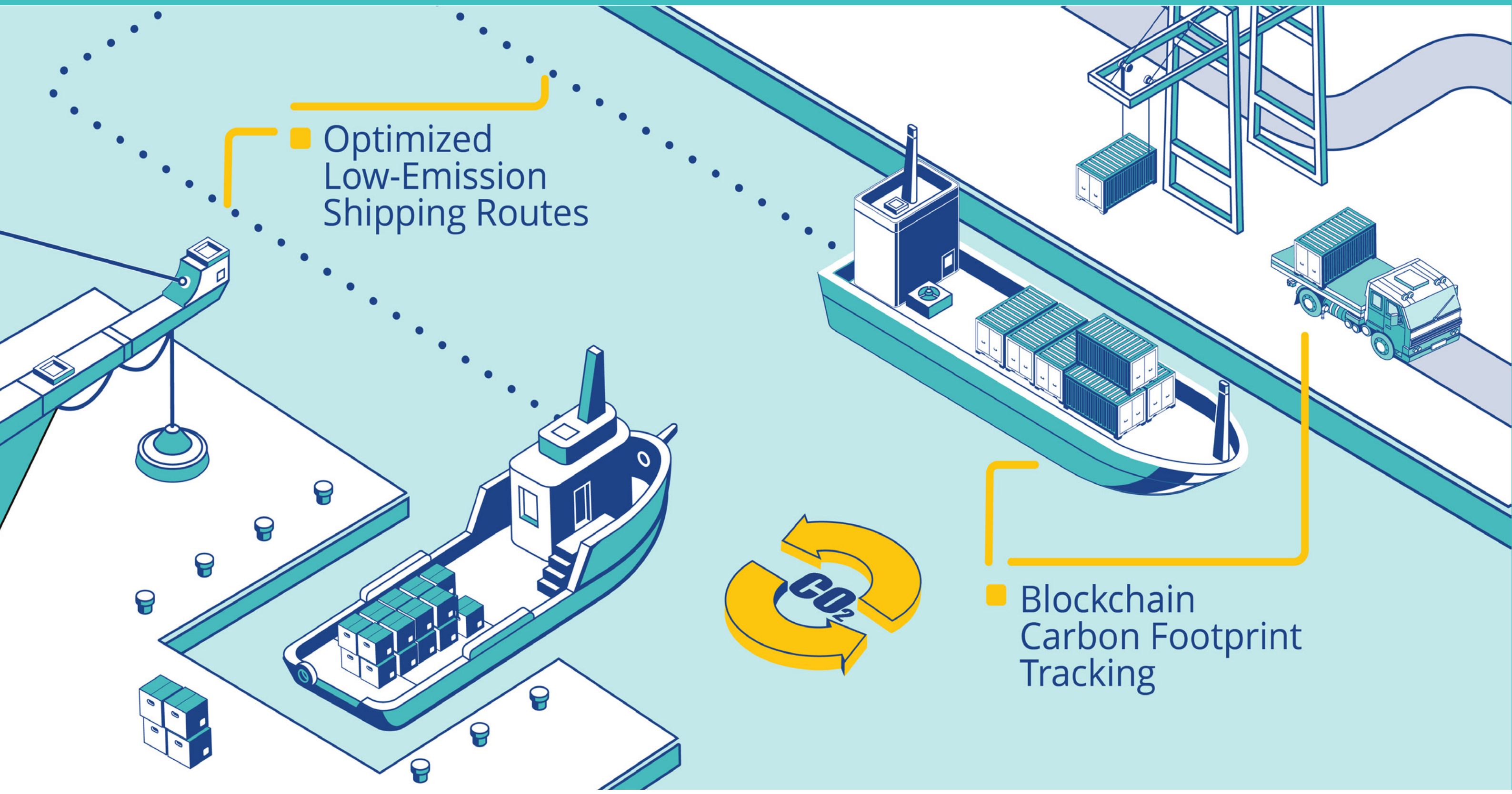
SCENARIOS

New route completion: When goods successfully arrive at the destination port, the transport service updates the route information, arrival times, and fuel/energy usage on the digital platform.

Annual Carbon Footprint audit: The Port Authority conducts an annual review of the carbon footprint related to transport operations. This process includes the retrieval of carbon footprint metrics and assessments of potential savings.

UC VI CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

OWNER: AP VIGO



TARGET COUNTRIES

- SPAIN
- PORTUGAL
- ANY OTHER PORT OR INLAND WATERWAY IN EUROPE

MAIN FEATURES

- CROSS BORDER
- EDGE
- OUTERMOST
- CLOUD
- TRAFFIC AND LOGISTIC
- INFORMATION

STAKEHOLDERS

- PORT OPERATORS
- SHIPPING COMPANIES
- LOGISTICS COMPANIES
- MANUFACTURERS
- CONSUMERS/CITIZEN

UC VI

CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

OBJECTIVES

- Compare transport combinations based on the carbon footprint (CF).
- Combine information from several stakeholders to enhance sustainability.
- Interoperability to increase trust in data quality among stakeholders.

CHALLENGES

- Lack of standardized methods for CF calculation.
- Integration of data across multiple logistic actors.
- High costs and complexity of implementing IT systems for SMEs.
- FIWARE as a standard for ports, architecture aims to be replicable considering this platform.
- Lack of knowledge about CF from outsiders (manufacturers, other transport actors, etc)

SCOPE

This UC aims to deliver standardized, reliable, and verifiable data on the carbon footprint of goods transportation, with a primary focus on port logistics. The goal is to create a comprehensive framework that integrates environmental impact data from various actors involved in the supply chain—such as manufacturers, logistics companies, and port operators—into a unified system.

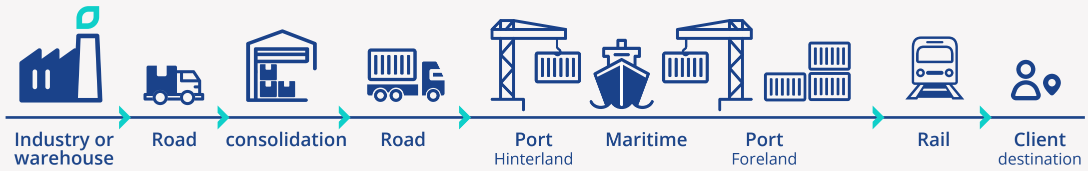
This will allow seamless interoperability and data exchange between stakeholders, reducing the complexity and cost of IT adoption, particularly for small and medium-sized enterprises (SMEs). By promoting the use of environmental data in decision-making processes, the system helps compare different transport options based on their carbon footprint.

This data-driven approach empowers companies to choose more sustainable logistics options, encourages transparency in environmental reporting, and enables consumers to make informed, eco-conscious decisions. Furthermore, the system aligns with EU regulations on electronic freight transport information, ensuring compliance and promoting sustainability at both a local and cross-border level.

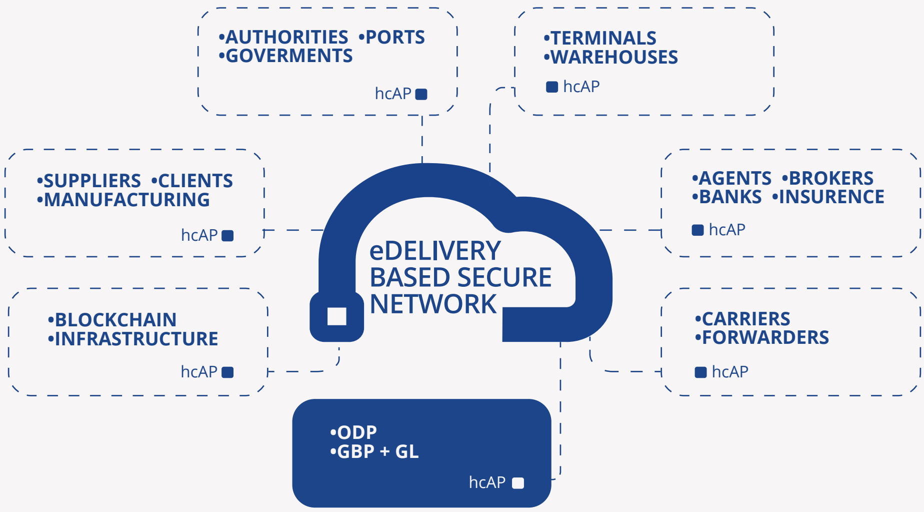
UC VI CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

DIAGRAM

COLLABORATION MANUFACTURING & LOGISTIC



BUSINESS COLLABORATIVE NETWORK



DIGITAL PLATFORM
ODP > GBP + GL & APPs

TOWER CONTROL

DIGITAL CATALOGUE | SEARCH | NEGOTIATE | BOOK & PLAN | EXECUTE | TRACK & TRACE

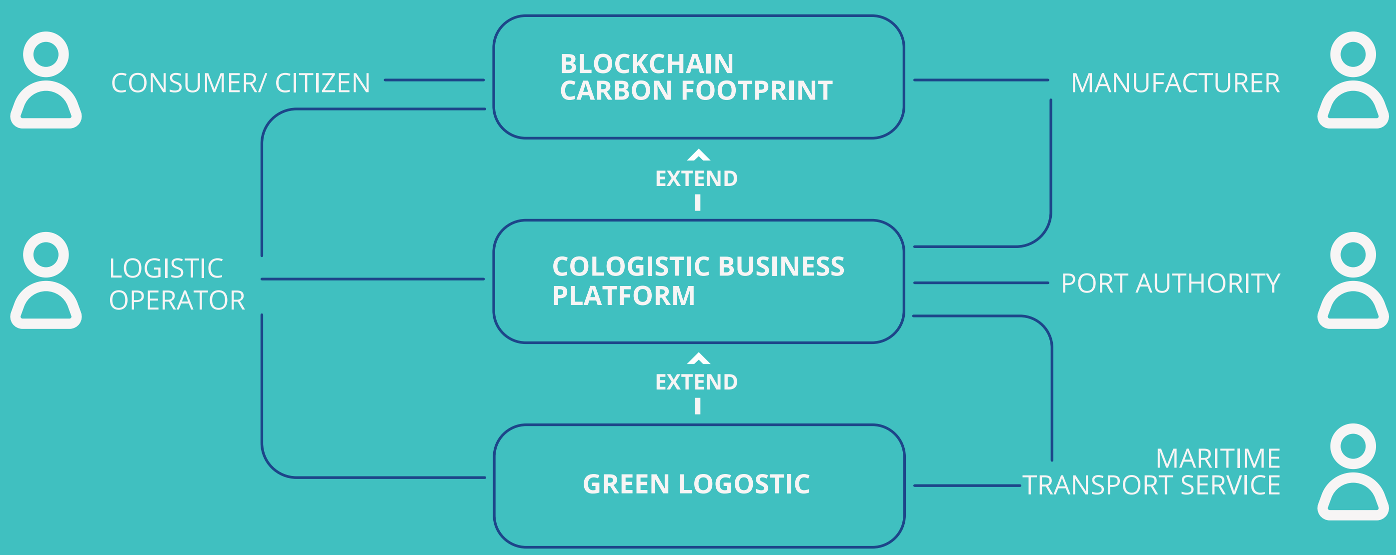
CARBON FOOTPRINT CALCULATION / INFORMATION

UC VI CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

ODP BUSINESS BENEFITS POTENTIAL

The ODP enhances logistics sustainability by integrating data from multiple sources to provide reliable carbon footprint calculations.
This platform uses advanced technologies like blockchain to track emissions and offers automated, cloud-based services to simplify logistics for SMEs.
By providing clear environmental impact data, it encourages greener logistics choices and helps stakeholders make informed decisions about cost, time, and environmental impact.

PLATFORM BOUNDARY



OVERVIEW OF KEY TECHNOLOGIES, FRAMEWORKS, AND TOOLS

Green blockchain: ensures data integrity, security, and transparency in tracking the carbon footprint throughout the logistics chain in a cost-efficient manner.
It allows real-time validation of information across multiple stakeholders.

EU eDelivery Building Blocks: A set of digital services used to enhance data exchange between different logistics entities, ensuring interoperability and compliance with EU regulations. This framework facilitates secure and reliable communication between SMEs, logistics companies, and regulatory bodies.

CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

Cloud Computing: The Operational Digital Platform operates on a cloud-based infrastructure, providing scalable, cost-effective, and accessible services to logistics stakeholders. It enables hands-off digitalization, allowing companies, to benefit from advanced analytics and real-time data without heavy IT investment.

Data Analytics and IoT (Internet of Things): Integrates data from IoT devices (sensors, energy monitoring, etc.) to track fuel consumption, route efficiency, and other logistics variables. Advanced analytics process this data to calculate accurate carbon footprints and optimize logistics operations for lower emissions.

FULL NARRATIVE

Logistic operations, especially in ports, are key contributors to carbon emissions. The Operational Digital Platform addresses the challenges of fragmented data and varied methods of carbon footprint calculation.

By integrating logistics information from manufacturers, transport operators, and port authorities, the ODP ensures accurate, real-time carbon footprint tracking. This transparency allows for informed decisions regarding emissions reduction, boosting the visibility of eco-friendly services, and aiding end consumers in making environmentally responsible choices by labeling products with a complete carbon footprint lifecycle. The ODP also plays a crucial role in fostering collaboration across the supply chain, from local port authorities to global shipping operators.

It simplifies the process of sharing data between parties by leveraging cloud-based solutions and blockchain for secure, verifiable transactions. The platform is designed to be adaptable, allowing companies to comply with evolving EU regulations on electronic freight transport information while lowering IT adoption costs. Ultimately, the ODP serves as a catalyst for greener logistics operations, supporting the transition toward a sustainable, carbon-neutral supply chain by providing businesses with actionable insights and consumers with transparent environmental impact data.

UC VI

CARBON FOOTPRINT OF PORTS SUPPLY CHAIN

SCENARIOS

New Route Completed: Once goods reach a destination port, logistics operators update the ODP with CF data. Consumers and stakeholders can track the emissions linked to their products.

Port CF Auditing: The Port Authority downloads CF indicators, supporting annual audits and compliance with environmental regulations.

Logistics Optimization: Logistics companies use CF data to improve services, offering better transport options with reduced environmental impacts.

SYSTEM ARCHITECTURE AND CBA

SYSTEM ARCHITECTURE REQUIREMENTS

A generic reference architecture has been developed, comprising the following layers: perception, network, data, middleware, business, application, and security.

Key technical requirements have been identified to guide the next steps.

These are scalability, interoperability, security, data management and analytics, and reliability. The diagram on the next page provides a simplified representation of the concept.

The next project Phase involves adapting and applying such reference architecture, along with its key technical requirements, to each of the six selected use cases.

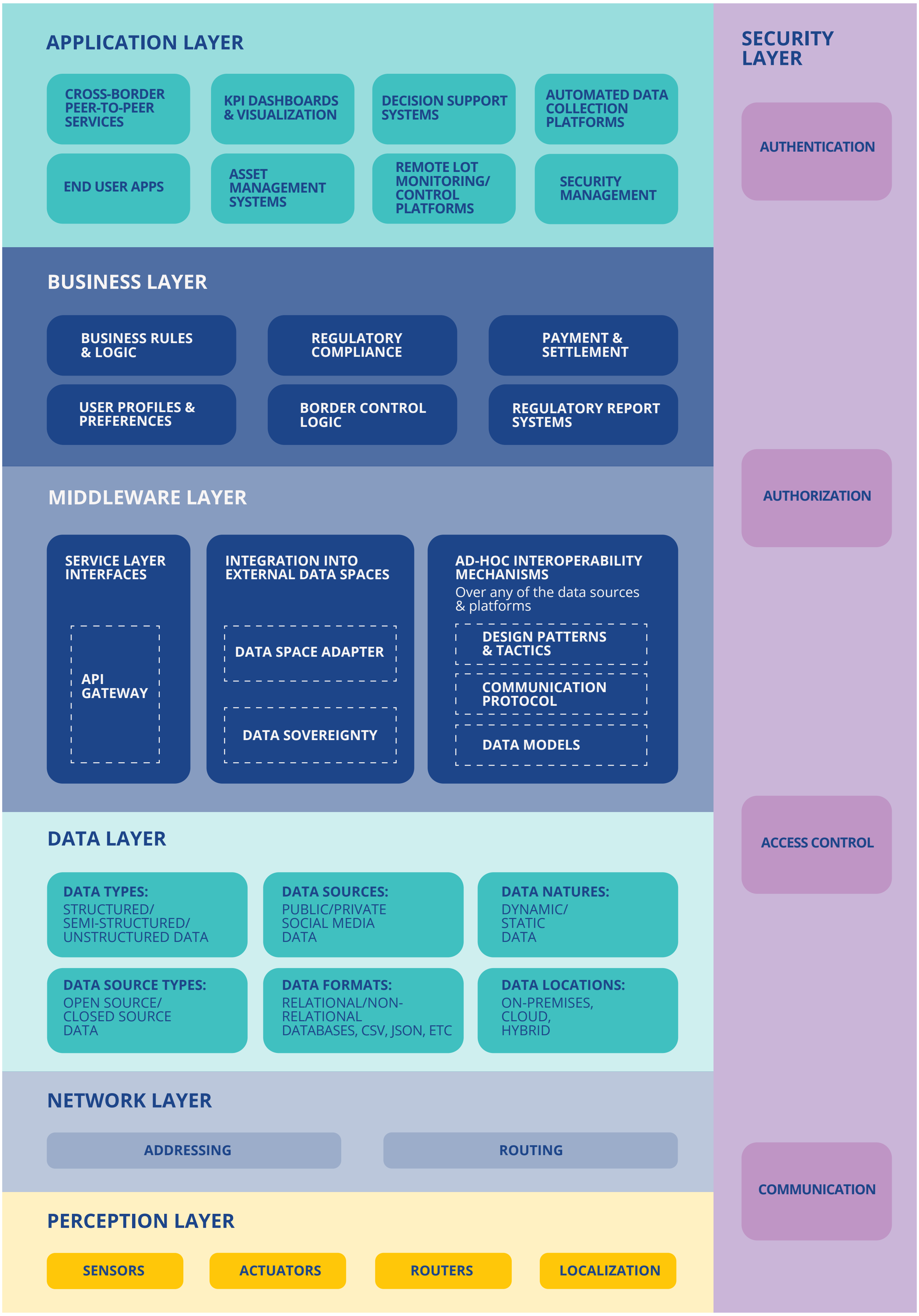
This will result in two deliverables. The first deliverable will be a detailed analysis of the most suitable technologies for each use case. The second deliverable will provide a system architecture and a governance framework for each use case.

COST-BENEFIT ANALYSIS METHODOLOGY

The framework we proposed to use for the cost-benefit analysis of digital platforms includes seven steps:

1. Define the project: comprehensive summary and outline of the project's key elements and objectives;
2. Map technologies to functions: which functionalities of the digital platform are activated by the technologies/assets;
3. Map functions to benefits: map the functionalities (identified in Step 2) on to the benefits that the digital platform provides, social, economic and environmental;
4. Monetize benefits: identification, collection, and reporting of the data required for the quantification and monetization of the benefits;
5. Quantify costs: quantify the expenses incurred during the implementation phase;
6. Compare costs and benefits (lifetime, discount rate and NPV);
7. Sensitivity analysis: study how the results of cost-benefit analysis may change with some critical parameters.

SYSTEM ARCHITECTURE AND CBA



CONCLUSIONS AND NEXT STEPS

NEXT STEPS OF THE PROJECT AND EVOLUTION OF THE USE CASES

The six selected use cases will be thoroughly assessed from a technological (architecture and data space), regulatory and a socio-economic perspective (cost-benefit analysis) in the project's second phase, which will conclude in June 2025.

Following this phase, the three use cases with the greatest impact will be selected for piloting, and the outcomes will be reported to the European Commission for consideration in future funding allocations.

Through the project website, technical reports, outreach materials, and events will be published, presenting the results obtained from the six use cases as well as the selection process leading to the final three use cases that will ultimately be piloted. Stakeholders are encouraged to participate and support us to define a common understanding of ODP and its application to cross-border contexts.

CONCLUSIONS

The use cases presented in this brochure do not reflect the interests of any specific entity or group; rather, they aim to achieve the highest socio-economic impact within the EU cross-border and cross-sectoral context of energy, mobility, and transport infrastructure. As such, the solutions and ideas proposed may be implemented by any entity with the capacity and initiative to do so.

Each use case has been described according to the possible functionalities it could adopt within a potential Operational Digital Platform. However, as technology (data spaces, AI, 5G, etc.) is continuously evolving, the descriptions and scope of these use cases may develop throughout the project. We also encourage all stakeholders to continue contributing in this regard. The true success of this initiative will lie in end-users understanding the benefits of an ODP as well as the economic advantages for all companies involved in its future design and deployment.

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