

Cluster 4: Smart Vineyards and Sustainable Winery Ecosystems

Use Case Overview Diagram



Ambition, Mission and Objectives

- Integrate smart vineyard, winery production, and IoT lifecycle management into a unified, interoperable digital ecosystem.
- Improve water efficiency, production performance, and operational visibility while reducing environmental footprint and electronic waste.
- Demonstrate scalable, EU-sovereign, and replicable digital solutions for sustainable viticulture and agri-food production.

Description

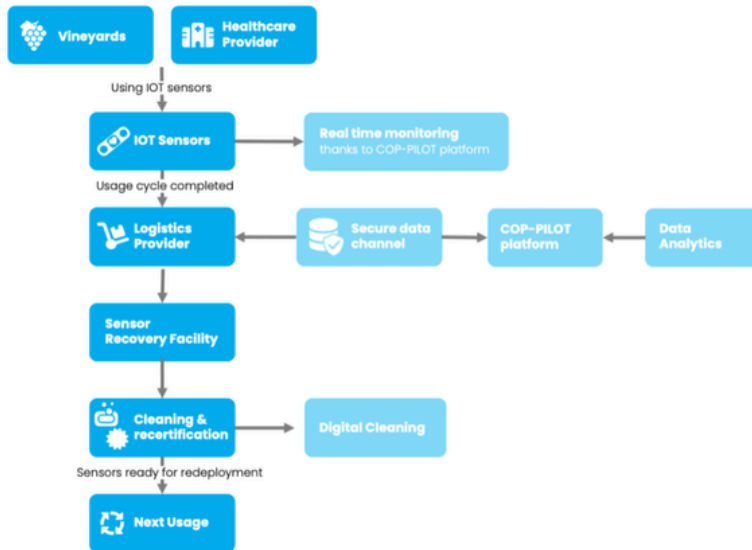
Smart Vineyards & Sustainable Winery Ecosystems demonstrates how IoT, AI, and ML can enable digital transformation across viticulture, winery production, and sustainability operations. Operating within an IoT–Edge–Cloud continuum, the cluster integrates smart vineyard management, optimized winery production lines, and circular lifecycle management of IoT devices. By unifying heterogeneous data sources and operational requirements, it validates scalable, GDPR-compliant solutions that improve resource efficiency, reduce environmental impact, and support circular economy principles within a representative vineyard–winery ecosystem.

Pathway to Execution

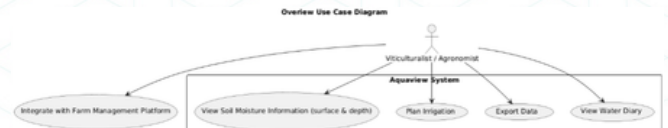
Execution relies on synchronising sustainability-driven business goals with technical orchestration across vineyards, wineries, and supporting partners. Business alignment focuses on measurable outcomes such as water savings, energy efficiency, reduced downtime, and circular reuse of IoT assets. Technically, execution depends on federated data management, open interfaces, and automated orchestration across the IoT–Edge–Cloud continuum. Continuous coordination between vineyard operators, winery managers, technology providers, and recycling partners ensures secure data governance, scalable deployment, and the translation of pilot results into replicable, market-ready solutions aligned with ESG objectives.

Cluster 4 Use Case Summary

UC 4.1

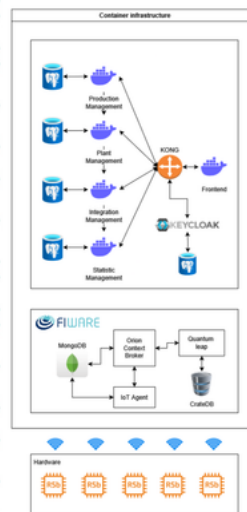


UC 4.2



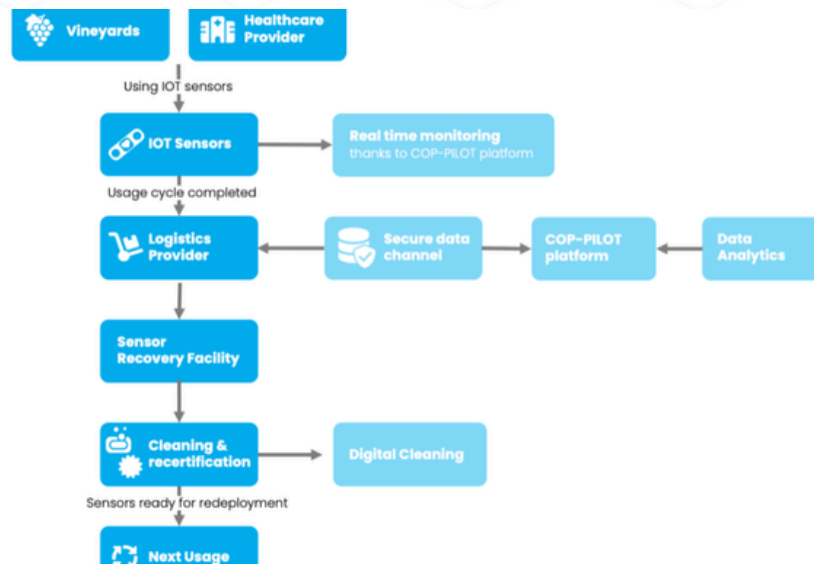
Aquaview is a sensorless soil-moisture system using satellite and weather data to provide high-resolution maps, predictions, and virtual moisture readings, helping optimise irrigation, reduce costs, and protect soil health.

UC 4.3



The IoT Wine Platform use case digitises a winery bottling line with real-time monitoring, anomaly detection, and predictive maintenance, unifying machine and system data to improve efficiency, reduce downtime, and support compliant, data-driven decisions.

Recycling, Maintenance, and Logistics of IoT Sensors



Description

This use case improves the sustainability and lifecycle management of reusable IoT sensors across healthcare, vineyards, and industrial environments. Using the COP-PILOT platform and RedZinc's DIRP, it enables a closed-loop process for monitoring, recovery, reuse, and recycling, reducing e-waste, lowering costs, and ensuring regulatory compliance.

Functional Requirements

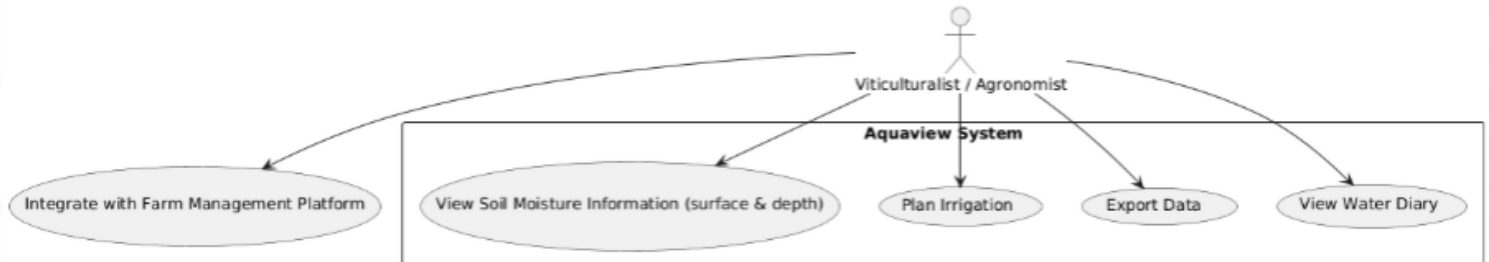
The use case requires a cloud-based, sovereign deployment that supports end-to-end IoT sensor lifecycle orchestration. Core functional requirements include a browser-based dashboard, centralized sensor registration with unique identifiers, and a logistics engine capable of tracking multiple lifecycle events per usage cycle. The system must support automated triggering of collection, cleaning, re-certification, and recycling workflows, alongside optional features such as real-time status tracking, digital cleaning certificates, and visibility through an IoT wallet. Secure integration with COP-PILOT ensures interoperable monitoring, predictable maintenance scheduling, and compliant data exchange across healthcare and agricultural environments.

Market Business Requirements

From a market perspective, the use case targets measurable cost reduction, scalability, and operational efficiency. It aims to reduce IoT procurement and maintenance costs by at least 30% through sensor reuse and predictive maintenance, while lowering integration and operational overhead via standardized orchestration workflows. The solution is designed to be scalable and replicable across multiple sectors and EU regions, with validation in at least three countries. By enabling high sensor reuse rates, lifecycle transparency, and reduced e-waste, the use case supports strong ESG value propositions and establishes a commercially viable, circular IoT asset management model applicable beyond healthcare and viticulture.

Water Utilisation Efficiency

Overview Use Case Diagram



Description

Aquaview is a sensorless soil-moisture intelligence system designed to improve water utilisation efficiency in agriculture. It combines satellite imagery with historical and forecast weather data to generate high-resolution (≈ 30 m radius) topsoil moisture maps, depth moisture estimates (via ML), and 7–14 day moisture predictions. Users define an area of interest and receive daily updates, alerts, and a “virtual moisture probe” reading for any point on their land, plus trends back to 2013. The goal is to optimise irrigation, cut costs, and protect soil health.

Functional Requirements

The solution must acquire remote and on-site inputs and turn them into actionable irrigation insights. It must download and process satellite data and capture supporting in-field measurements for calibration where available. It must compute topsoil moisture content and present results through interactive visualisation, including sector-by-sector moisture mapping within the user’s area of interest. It must also support irrigation planning by providing a timeline view of moisture retention trends over the past ten years, alongside current conditions and near-term predictions, so growers can decide when and where irrigation is required.

Market Business Requirements

For market adoption, Aquaview must deliver clear economic value versus sensor-heavy alternatives while scaling across regions. It must reduce long-term operational costs by at least 30% compared with traditional probe-based irrigation approaches, largely by minimising hardware deployment and associated maintenance. The system should be modular and scalable for expansion into new agricultural domains and geographies, demonstrating successful implementation in at least two countries with minimal configuration. It must also keep maintenance cost-effective through automated diagnostics, updates, and robust backup/failover mechanisms that enable $\geq 95\%$ automated recovery from data failures.

Sustainable Optimised Winery Production Lines

Description

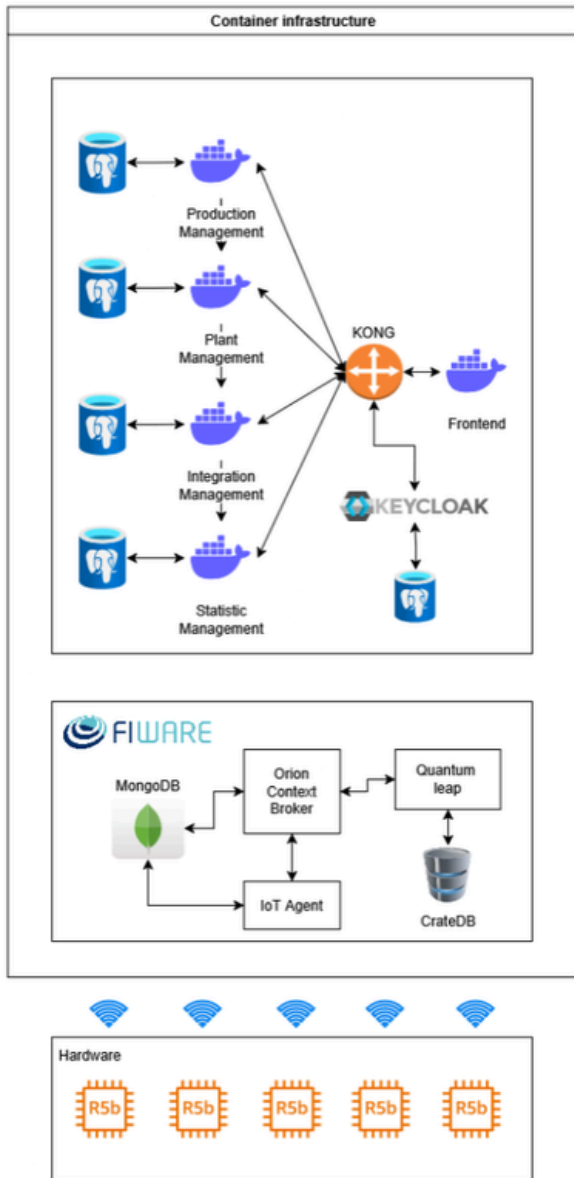
The IoT Wine Platform use case focuses on digitally transforming a winery's bottling line by enabling real-time monitoring, anomaly detection, and predictive maintenance. Through the deployment of IoT sensors, edge devices, and COP-PILOT orchestration, data from industrial machinery, operators, ERP, and MES systems is unified into a single interoperable platform. This provides end-to-end visibility across all bottling stages, reduces downtime, improves operational efficiency, and supports data-driven decision-making while ensuring EU data sovereignty and GDPR compliance.

Functional Requirements

The functional requirements for this use case include continuous real-time data capture from bottling line sensors, automated integration with ERP and MES systems, and standardized data exchange using NGSI-LD. The platform must calculate and report OEE metrics, detect anomalies, and trigger alerts for operational deviations. It should provide interactive dashboards for operators and managers, support historical analysis, and enable scalable deployment and orchestration of services across edge and cloud environments with low latency and high availability.

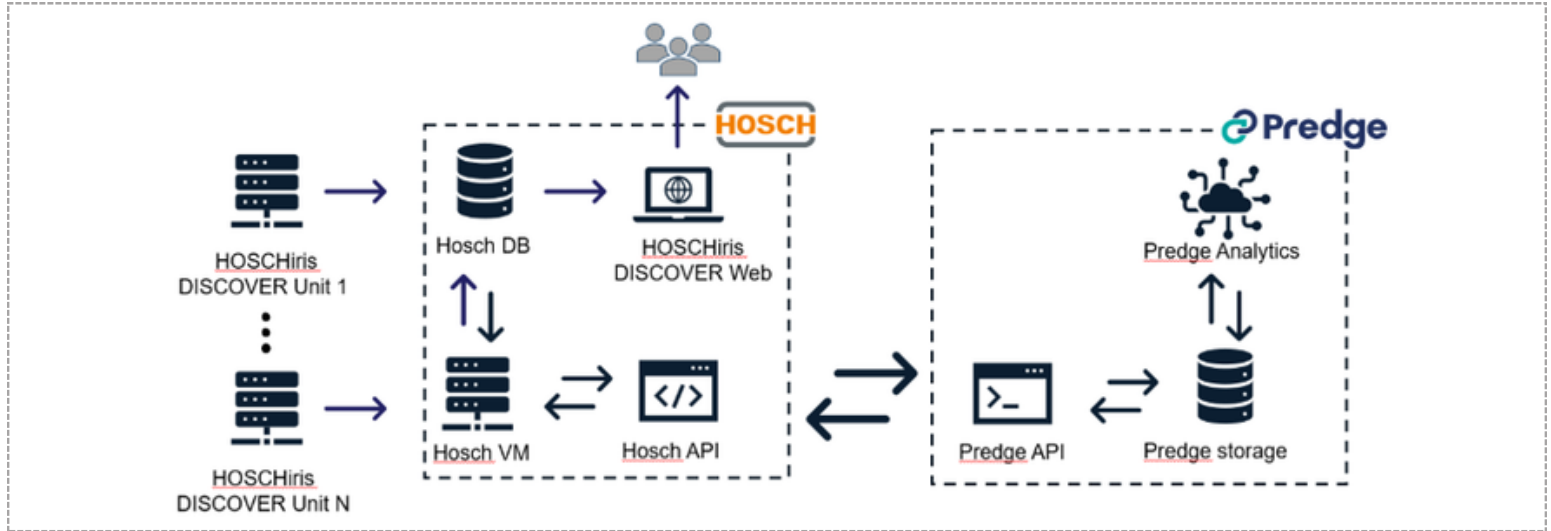
Market Business Requirements

The market business requirements aim to ensure cost efficiency, scalability, and interoperability for widespread adoption in the wine sector. The solution must significantly reduce operational costs by minimizing manual work, downtime, and production losses through automation and predictive maintenance. It should integrate seamlessly with existing winery systems, support modular expansion to other production processes, and offer a replicable model for other agri-food industries. Long-term value creation is driven by improved productivity, reliability, and competitiveness.



Use Case 4.4

Use Case Title



Description

Text

Functional Requirements

Text

Market Business Requirements

Text



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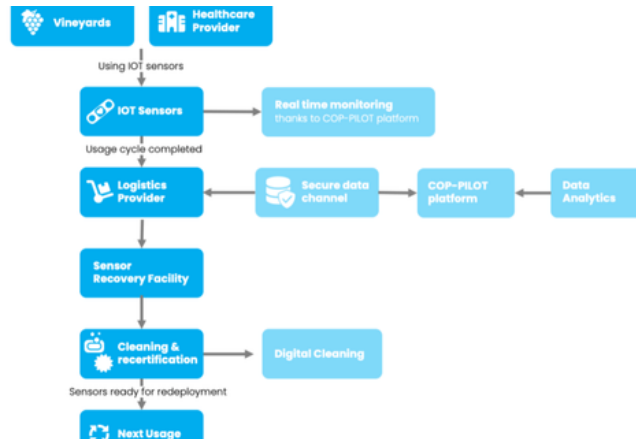
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Use Case 4.1

Recycling, Maintenance, and Logistics of IoT Sensors



Description

This use case improves the sustainability and lifecycle management of reusable IoT sensors across healthcare, vineyards, and industrial environments. Using the COP-PILOT platform and RedZinc's DIRP, it enables a closed-loop process for monitoring, recovery, reuse, and recycling, reducing e-waste, lowering costs, and ensuring regulatory compliance.

Instantiation of Use Case

For the 4.1 use case, we create a COP-PILOT-enabled service for the monitoring, maintenance, replacement, and recycling of IoT sensors deployed in vineyard and related operational environments. Sensor measurements and lifecycle signals (e.g. battery low, fault, end-of-use) are collected and translated into FIWARE/NGSI-LD entities, then securely managed through the COP-PILOT platform. The COP-PILOT orchestrator supports the deployment of the RedZinc lifecycle services and their integration with the Secure Integration Fabric and eUd-compatible digital wallets, enabling real-time tracking of sensor condition, automated trigger generation, and coordinated recovery or recycling workflows across suppliers, users, and logistics actors.

Functional Requirements

The use case requires a cloud-based, sovereign deployment that supports end-to-end IoT sensor lifecycle orchestration. Core functional requirements include a browser-based dashboard, centralized sensor registration with unique identifiers, and a logistics engine capable of tracking multiple lifecycle events per usage cycle. The system must support automated triggering of collection, cleaning, re-certification, and recycling workflows, alongside optional features such as real-time status tracking, digital cleaning certificates, and visibility through an IoT wallet. Secure integration with COP-PILOT ensures interoperable monitoring, predictable maintenance scheduling, and compliant data exchange across healthcare and agricultural environments.

The real benefit in the use case

Use case 4.1 benefits from COP-PILOT by turning IoT sensor lifecycle management into an interoperable, secure, and scalable service rather than a standalone workflow. COP-PILOT provides the orchestration, FIWARE-based interoperability, secure data exchange, and eUd wallet integration needed to automate maintenance and recycling processes across distributed environments. This enables better traceability, lower replacement costs, reduced e-waste, and stronger compliance with GDPR and EU data sovereignty principles, while also making the solution reusable across vineyards, wineries, and other IoT-intensive sectors.

Market Business Requirements

From a market perspective, the use case targets measurable cost reduction, scalability, and operational efficiency. It aims to reduce IoT procurement and maintenance costs by at least 30% through sensor reuse and predictive maintenance, while lowering integration and operational overhead via standardized orchestration workflows. The solution is designed to be scalable and replicable across multiple sectors and EU regions, with validation in at least three countries. By enabling high sensor reuse rates, lifecycle transparency, and reduced e-waste, the use case supports strong ESG value propositions and establishes a commercially viable, circular IoT asset management model applicable beyond healthcare and viticulture.



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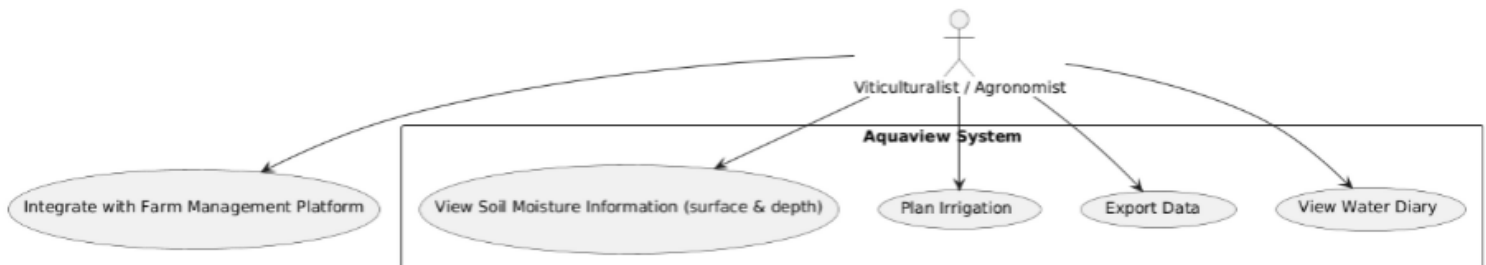
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Use Case 4.2

Water Utilisation Efficiency

Overview Use Case Diagram



Description

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Functional Requirements

The solution must acquire remote and on-site inputs and turn them into actionable irrigation insights. It must download and process satellite data and capture supporting in-field measurements for calibration where available. It must compute topsoil moisture content and present results through interactive visualisation, including sector-by-sector moisture mapping within the user’s area of interest. It must also support irrigation planning by providing a timeline view of moisture retention trends over the past ten years, alongside current conditions and near-term predictions, so growers can decide when and where irrigation is required.

Market Business Requirements

For market adoption, Aquaview must deliver clear economic value versus sensor-heavy alternatives while scaling across regions. It must reduce long-term operational costs by at least 30% compared with traditional probe-based irrigation approaches, largely by minimising hardware deployment and associated maintenance. The system should be modular and scalable for expansion into new agricultural domains and geographies, demonstrating successful implementation in at least two countries with minimal configuration. It must also keep maintenance cost-effective through automated diagnostics, updates, and robust backup/failover mechanisms that enable $\geq 95\%$ automated recovery from data failures.

Instantiation of Use Case

For the 4.2 use case, we create an edge-to-cloud system to optimize irrigation in agricultural parcels. We are using or installing soil moisture IoT sensors which data acquisition is directly fed into our soil moisture estimation model so that we get real-time data insights which is helping to produce a better soil moisture estimate. This captured real-time data from sensors are processed on the edge device available in the farm before being securely transmitted to the FIWARE Orion Context Broker. The COP-PILOT orchestrator automates the deployment of those services either on the edge or on the cloud to ensure a seamlessly processing of the field information to obtain a soil moisture map which helps growers to take decisions about their irrigation plan.

The real benefit in the use case

Use case 4.2 aims to develop a multi-layer orchestrated infrastructure managing collaborative services across distributed and heterogeneous environments, supporting IoT and edge devices in its Aquaview solution. It benefits from the automated IoT-to-cloud continuum tool for scalable deployment, large-scale pilot infrastructures, and cross-sector use cases to develop an accurate solution for growers. Aquaview contributes to COP-PILOT aims not only by demonstrating sustainable water management but also focuses on market validation, sustainability impact, and promoting adoption through standardization and dissemination, showcasing the platform’s practical and scalable potential.



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Use Case 4.3

Sustainable Optimised Winery Production Lines

Description

The IoT Wine Platform use case focuses on digitally transforming a winery's bottling line by enabling real-time monitoring, anomaly detection, and predictive maintenance. Through the deployment of IoT sensors, edge devices, and COP-PILOT orchestration, data from industrial machinery, operators, ERP, and MES systems is unified into a single interoperable platform. This provides end-to-end visibility across all bottling stages, reduces downtime, improves operational efficiency, and supports data-driven decision-making while ensuring EU data sovereignty and GDPR compliance.

Functional Requirements

Real-time sensor data capture, ERP/MES integration, NGS-LD data exchange, OEE calculation/reporting, anomaly detection with alerts, interactive dashboards, historical analysis, and scalable edge-to-cloud orchestration with low latency and high availability.

Market Business Requirements

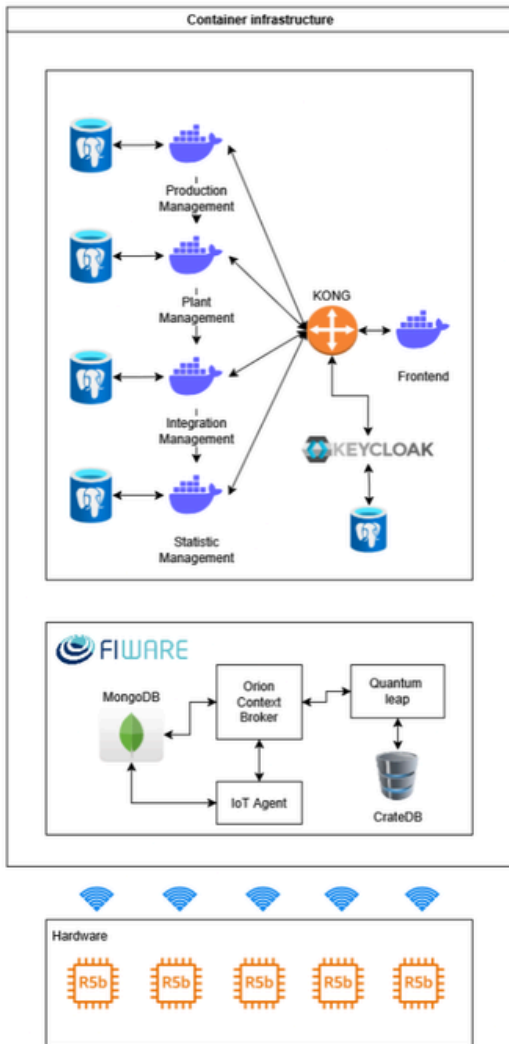
The market business requirements aim to ensure cost efficiency, scalability, and interoperability for widespread adoption in the wine sector. The solution must significantly reduce operational costs by minimizing manual work, downtime, and production losses through automation and predictive maintenance. It should integrate seamlessly with existing winery systems, support modular expansion to other production processes, and offer a replicable model for other agri-food industries. Long-term value creation is driven by improved productivity, reliability, and competitiveness.

The real benefit in the use case

By applying this architecture within the COP-PILOT system, the primary value-add lies in transforming a traditionally manual and fragmented wine production process into an agile, data-driven ecosystem. Consolidating heterogeneous data sources—ranging from automated sensor readings to calculated Overall Equipment Effectiveness (OEE) metrics and manual operator inputs—into a unified overview empowers production supervisors to make rapid, informed decisions. This real-time visibility enables immediate anomaly detection and triggers automated alerts before minor deviations result in costly downtime. Furthermore, this system is projected to reduce manual data entry intervention by twenty percent and significantly decrease operational human errors. Beyond immediate operational efficiency, this seamless orchestration ensures our data processing remains fully compliant with EU digital sovereignty and GDPR standards, proving that advanced digital transformation in the wine industry can be both highly sustainable and secure.

Instantiation of Use Case

To set up this use case, we are deploying a hybrid edge-cloud infrastructure to achieve comprehensive, real-time control over the winery's bottling operations. We install IoT sensors connected to Raspberry Pi edge devices directly along the production line to monitor critical machinery, including labellers, capsule machines, and ABB robots. These edge devices capture real-time data and securely transmit it via RabbitMQ to a centralized platform. From there, the COP-PILOT orchestrator automates the deployment of services and configures the necessary IoT agents, seamlessly normalizing the data into an NGS-LD format for the FIWARE Orion Context Broker. This automated orchestration integrates the live sensor feeds with our enterprise systems, such as ERP and MES, and routes historical data into QuantumLeap and CrateDB. Ultimately, this architecture establishes the foundation for advanced trend analysis and predictive maintenance without the need for manual, server-by-server configuration.



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Use Case 4.4

AI Driven Green Energy Vineyard Management

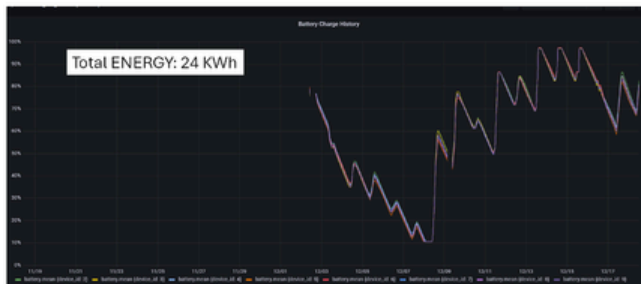
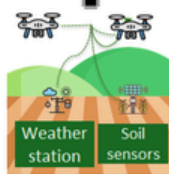
 **NOKIA Vineyards
5G Green-Site**

**Network
as Code
(NaC)**

 **coppilot
Domain Orch.**

**NOK Energy
Mgmt (UI)**

 **coppilot
Data Mgmt.**



Description

Green Energy management in isolated locations is critical for services deployments when is the only energy available. The accounting of energy use for each deployed and activated device on efficient sites is key for service availability. The 5G/6G connectivity is critical for services deployment, so the efficient management of the energy associated to communications is mandatory. The remote control of switch-on or switch-off the deployed devices will guarantee the optimization of the available energy to use just what is needed optimizing the energy use Integration of future available energy will be also supported taking as input weather forecast

Functional Requirements

Collect the energy use of devices using site energy. Collect energy available on the batteries of the site. Generate energy available forecast on the site taking external weather forecast information. Integrate remote control of energy switch-on or switch-off of any device on the site. Integrate the remote control of energy switch-on or switch-off of mobile network radio layers on the area. Train algorithms to optimize the efficient use of the available green energy for the overall site. Collect and store IoT weather and soil; stations already deployed in the area. Integrate the provision and management of new mobile network: connected devices with several profiles and QoS.

Market Business Requirements

The solution must enable continuous service availability in remote or off-grid environments by optimizing renewable energy usage across deployed devices. It must monitor real-time energy production, storage, and consumption to ensure efficient allocation for critical telecom infrastructure such as 5G and future 6G systems. To reduce operational costs and improve sustainability, the solution must apply forecasting and AI-based optimization to match expected renewable energy supply with service demand. Using external: weather data and predictive analytics, it must enable proactive energy planning, prioritization of devices, and reduced reliance on backup power

Instantiation of Use Case

For the 4.4 use case, we implement an intelligent energy management system for rural and off-grid telecom infrastructures, integrating renewable energy sources, battery storage systems, and 5G network equipment. Real-time data from energy production, storage, and consumption are collected through IoT sensors and normalized into FIWARE/NGSI-LD entities. These data streams are processed at the edge and securely transmitted to the FIWARE Orion Context Broker. The COP-PILOT orchestrator enables automated deployment and lifecycle management of energy-aware services across edge and cloud environments, incorporating weather data and forecasting models to support predictive energy optimization and dynamic decision-making, such as switching 5G radio equipment on/off and relocating applications based on energy availability.

The real benefit in the use case

The benefits from COP-PILOT by enabling a fully orchestrated, interoperable, and AI-driven energy optimization framework. It ensures continuous service availability in energy-constrained environments while reducing operational costs and energy waste. The platform supports proactive energy planning, device prioritization, and automated responses to energy fluctuations, significantly reducing reliance on backup power sources. Additionally, it enhances sustainability, resilience, and scalability of telecom infrastructures, while ensuring compliance with EU data sovereignty and enabling replication across similar rural and off-grid scenarios for future 5G and 6G deployments.



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