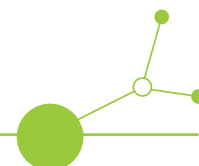


Evaluation Report on Pilot Actions

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1. Introduction

The REDU-CE-D project, short for "customized Environmental Management System (EMS) to increase energy efficiency and reduce energy consumption of different transport modes in Central Europe," aims to enhance energy efficiency across various transportation sectors in Central Europe. This project addresses the requirements of the EU's Energy Efficiency Directive (EED), which mandates member states to achieve specific energy efficiency targets.

The primary goal of REDU-CE-D is to transpose the EED to the air, urban, waterway, and rail transport sectors by developing and implementing customized EMS packages. These systems will be tailored to meet EU requirements and will be tested, developed, and disseminated through a collaborative, transnational approach.

The project adopts a cooperative strategy that involves assessing, mapping, and evaluating best practices for monitoring energy consumption in the transport sector at the Central European level. A Transnational Working Group will assess the adaptability of selected practices and provide strategic inputs for their implementation. The findings will be showcased at the REDU-CE-D Conference.

1.1. Purpose of the report

This Evaluation Report presents the results of the pilot implementation of the Environmental Management System (EMS) packages carried out by the project partners. Its main purpose is to assess the effectiveness, feasibility, and applicability of the developed EMS packages in different implementation contexts, based on the evidence collected during the pilot actions.

The report consolidates the outcomes of testing activities, monitoring results, and evaluations of the defined Key Performance Indicators (KPIs). It identifies the main achievements, implementation barriers, lessons learned, and opportunities for improvement that emerged during the pilot phase. Particular attention is given to organisational, technical, and operational aspects that may influence the successful adoption of EMS practices, including issues related to organisational data management, understanding of ISO 14001 and ISO 50001 requirements, allocation of responsibilities, management commitment, and prioritisation of EMS implementation.

The findings presented in this report will support the refinement, finalisation, and validation of the EMS packages, ensuring that they are practical, effective, and adaptable to the needs of different organisations.

1.2. Evaluation approach

The evaluation was conducted through a collaborative approach involving all project partners. The assessment combines quantitative and qualitative evidence gathered throughout the pilot implementation phase. Data collected through the Pilot Implementation Grid and the dedicated digital monitoring tool were integrated with the monitoring activities coordinated by Romagna Tech and the evaluation of the project KPIs performed by the University of Maribor.

Each partner contributed information on the implementation process within its pilot site, including the activities carried out, observed results, encountered challenges, and feedback from participating organisations. These contributions were consolidated using a common Evaluation Report template to ensure consistency across all pilot sites.

The evaluation methodology focuses on:

- a. assessing the implementation process and the degree of adoption of the EMS packages;



- b. analysing the achievement of the predefined KPIs;
- c. identifying strengths, weaknesses, barriers, and enabling factors;
- d. evaluating the adaptability and usability of the EMS packages in different organisational settings;
- e. formulating recommendations for further improvements and future implementation.

This joint evaluation provides a comprehensive understanding of the pilot outcomes and establishes the evidence base for the validation of the project's final EMS packages.

1.3. Scope of the pilot actions

The pilot action consisted of the practical implementation and testing of the developed EMS packages across the four participating transportation modes (railway, air, urban and waterway transport) . Each transport mode applied the relevant components of the EMS package according to its organisational characteristics and operational context, while following the common implementation methodology defined within the project.

The scope of the pilot action included the execution of the planned implementation activities, the collection of monitoring data, the assessment of the defined KPIs, and the documentation of experiences, challenges, and achieved results. The evaluation considers both the implementation process and the outcomes obtained at each transport mode, enabling a comparative analysis of the different implementation contexts.

This report provides an overview of the methodology adopted, a description of each implementation site and the activities performed, and an assessment of the effectiveness and adaptability of the EMS packages. Based on the collected evidence, it presents conclusions regarding the suitability of the developed solutions and proposes recommendations, future actions, and improvement measures aimed at enhancing the efficiency, feasibility, and long-term sustainability of the EMS packages.



2. Evaluation Methodology

2.1. Monitoring framework

The evaluation methodology is based on a common monitoring framework developed to ensure a harmonised collection of data across all pilot implementation sites. The framework builds on the general Environmental Management System (EMS) principles described in the previous chapter, including the Plan-Do-Check-Act (PDCA) approach and the requirements of internationally recognised management standards such as ISO 14001, ISO 50001, and EMAS. These standards provide the common methodological basis for monitoring environmental and energy performance, supporting continual improvement, regulatory compliance, and the assessment of the effectiveness of the implemented EMS actions across all transport modes.

The monitoring framework consists of four dedicated Microsoft Excel templates, each specifically designed for one of the transport modes addressed by the project:

- a. Air Transport;
- b. Waterway transport;
- c. Rail Transport;
- d. Urban Transport.

Each template has been shared with all project partners involved in the pilot implementation and includes a predefined set of monitoring parameters to ensure data comparability among the different pilot sites.

The templates collect two main categories of information:

- a. Energy performance indicators, including the energy consumption values associated with the monitored activities or facilities;
- b. Contextual and operational parameters, namely variables that may influence energy consumption and are therefore necessary to correctly interpret performance variations. These include operational data, activity levels, environmental conditions, passengers, or other transport-specific parameters, depending on the pilot site.

This common monitoring framework provides the basis for both the individual evaluation of each pilot and the comparative analysis across all implementation sites.

2.2. Monthly monitoring activities

PDCA Monitoring activities were carried out on a monthly basis throughout the pilot implementation period. Each project partner was responsible for collecting the required data from its implementation site and completing the corresponding monitoring template.

The monthly reporting frequency was selected to achieve an appropriate balance between data availability, monitoring effort, and the need to identify performance trends over time. Regular data collection also enabled the timely identification of anomalies, missing information, or unexpected variations in energy performance.

After completing the monitoring templates, partners submitted the updated files according to the agreed project schedule. The collected information was subsequently reviewed to verify data consistency and completeness before being consolidated within the common project database.



The continuous monitoring process ensured that the implementation of the EMS packages could be followed throughout the pilot phase, allowing the evaluation to consider not only the final results but also the evolution of performance during implementation.

2.3. Power BI platform

To facilitate data analysis and support the evaluation process, all monitoring data collected from the pilot sites were integrated into a digital dashboard developed using Microsoft Power BI.

The platform automatically imports the information contained in the monthly monitoring templates and processes the data to generate interactive visualisations and performance indicators.

The dashboard allows project partners to analyse the collected information at different levels, including:

- a. individual pilot site performance;
- b. transport mode performance;
- c. aggregated project-level results;
- d. temporal evolution of monitored indicators;
- e. comparison between different implementation sites.

The Power BI platform provides a dynamic and user-friendly environment for exploring the monitoring results, enabling partners to identify trends, compare performance among pilots, and support evidence-based decision-making throughout the evaluation process.

Furthermore, the platform contributes to improving transparency and consistency by ensuring that all partners access the same updated information and performance indicators.

2.4. Data collection process

The data collection process follows a standardised workflow designed to guarantee consistency and reliability across all pilot implementations.

Each month, partners collect the required operational and energy-related data directly from their pilot sites using the monitoring template corresponding to their transport mode. The updated templates are then submitted for validation and consolidation.

Following data validation, the information is imported into the Power BI platform, where it is processed to calculate the relevant indicators and generate the visual dashboards used during the evaluation activities.

The collected dataset constitutes the primary evidence base for assessing the implementation of the EMS packages. In addition to the quantitative monitoring data, qualitative information regarding implementation experiences, encountered challenges, organisational aspects, and lessons learned is collected through partner feedback and integrated into the overall evaluation process.

The combination of quantitative and qualitative information enables a comprehensive assessment of both the technical performance and the practical feasibility of the implemented EMS solutions.



2.5. Baseline definition

The evaluation of the pilot actions is based on the comparison between the monitored performance during implementation and a baseline representing the initial operating conditions of each pilot site.

The baseline establishes the reference against which improvements in energy performance and operational efficiency can be assessed. Since the participating pilot sites differ in terms of organisational structure, operational characteristics, infrastructure, and transport mode, the baseline was defined individually for each implementation site.

Whenever available, baseline values were established using historical energy consumption data collected prior to the implementation of the EMS package. Where historical datasets were limited, the first available monitoring period was adopted as the reference condition, complemented by contextual operational information to ensure an appropriate interpretation of the results.

The use of site-specific baselines allows the evaluation to account for the intrinsic differences among pilot sites while maintaining a common methodological approach across the project. This approach ensures that observed performance variations can be interpreted in relation to the actual operational context of each pilot rather than through direct comparison of absolute consumption values.

The baseline therefore represents a fundamental element of the evaluation methodology, supporting the assessment of the effectiveness of the EMS packages and providing the reference for measuring improvements achieved during the pilot implementation period.



3. Pilot Site Overview

3.1. Railway Transport

3.1.1. Railway Transport case description

The pilot action at Adriafer is designed to demonstrate that a rail shunting operator in a port environment can launch, with rapid timelines and focused investments, a measurable, economically sound, and replicable decarbonization pathway. The overarching goal is to design and test, under real operating conditions, an integrated Energy Management & Operations package (EMS+Ops) that reduces fuel and power consumption and associated emissions in first/last-mile activities, while optimizing yard management and maintaining or improving service levels for terminal operators and railway undertakings.

There are four specific objectives:

- Build a reliable energy baseline for shunting operations (locomotives, idling, light-engine moves, auxiliaries) and for the electrical consumption of operational sites, introducing metering, traceability, and a measurement & verification (M&V) plan aligned with ISO 50001 principles.
- Identify and validate low-cost operational quick wins—idle-time reduction, eco-driving, smoothing of speed profiles, consolidation of moves, and track-layout refinements—that produce immediate savings in diesel and CO₂ equivalent.
- Design a technical roadmap for “smart electrification” of the controllable perimeter (electrification of auxiliaries, charging solutions, and pre-equipment for alternative/hybrid traction where and when it is cost-effective).
- Set up a digital decision-support dashboard (KPIs and alerts) that integrates energy, operations, and safety.

The pilot’s value is both methodological and industrial. Methodologically, the project follows the Plan-Do-Check-Act cycle: planning (diagnosis, baseline, targets), execution (field trials of organizational and technological measures), verification (M&V and KPI tracking), and corrective action (scale-up or pivot). Industrially, the pilot addresses the real-world constraints of a complex port node such as Trieste: irregular demand, tight operating windows, multi-actor coordination, and stringent safety requirements. Proving benefits in this setting means generating results that are transferable to other ports and shunting companies.

The Pilot Action is structured around three integrated streams:

- Stream A — “Metering & Data”: installation/integration of meters and telemetry on locomotives and yard equipment; normalization of data (traces, dwell times, power profiles); and a clear approach to data quality and data governance;
- Stream B — “Analytics & Decision Support”: development of operational and energy indicators (l/h, l/move, CO₂ per serviced train, % time spent idling, shunting punctuality, track utilization) alongside simple recommendation algorithms (e.g., re-ordering missions to reduce dead time) and
- Stream C — “Operational Change”: operating procedures for driving and idling, anti-idle policies, coupling/uncoupling rules, micro-maintenance actions that improve efficiency, and targeted training for crews and yard control staff.



Measurability is central. The pilot sets KPIs with realistic 6-12-month targets: -8-12% diesel per movement, -10% CO₂ per train served, -15% idle time, +3-5% shunting punctuality versus baseline, as well as the reduction of generated general waste (-10%). Each KPI is paired with a technical sheet (definition, data source, frequency, owner, alert thresholds) and an M&V protocol designed to separate the effect of measures from demand variability.

The Pilot Action generates practical outputs with value beyond the project perimeter:

- an Energy Management Plan tailored to a port shunting operator;
- a “replicability kit” (templates for baselines, KPIs, SOPs, and metering/data-quality checklists) and
- a business-case note quantifying the investment costs and payback, including potential financing levers and synergies with system-level initiatives (port authority, terminal operators, railway undertakings).

Where relevant, the dashboard will interface with existing digital platforms (e.g., shunting-planning systems, Port Community System) to maximize operational utility and minimize data-entry burden.

Lastly, the pilot has a clear governance and skills dimension. It brings drivers, planning, maintenance, and HSE to the same table from day one, forming an operational working group that validates data, interprets KPIs, and decides corrective actions. This fosters internal ownership and supports the adoption of measures beyond the project’s duration. In short, the purpose of the Adriafer Pilot Action is to turn the energy transition from slogan to practice: measure, test in the field, demonstrate results, and leave behind a scalable operating model for rail shunting in port environments.

3.1.2. EMS implementation

The primary objective of the Adriafer pilot is to consolidate an Energy Management System (EMS) consistent with the principles of ISO 50001 and EMAS. The system aims to combine technical monitoring with organizational engagement (through training and reporting routines). To test the EMS implementation, Adriafer selected the indicators shown in Table 1.

Table 1: Indicators used in the railway transport EMS implementation.

Indicator	Description	Measurement frequency
Shunting Hours [h]	/	Monthly
Number of Wagons moved	/	Monthly
Hydrotreated Vegetable Oil (HVO) consumption [l]	/	Monthly
Diesel consumption [l]	/	Monthly
Total fuel consumption [l]	Consumption of both HVO and Diesel.	Monthly
Estimated CO ₂ emissions [kg]	CO ₂ emissions calculated from diesel and monthly electricity use, using standard emission factors.	Monthly
Average NO _x emissions [ppm]	NO _x emissions at the exhaust level.	Monthly
PM concentration [µg/m ³]	PM concentration in yard traction zones.	Monthly
Average Noise level [dB(A)]	Average noise level during shunting.	Monthly
Dust concentration [mg/m ³]	Dust concentration during yard movements.	Monthly



Indicator	Description	Measurement frequency
Waste from maintenance [kg]	Waste produced by monthly maintenance and depot operations.	Monthly
EMS integration in operations [%]	Percentage of EMS integration in operations.	Monthly
Implemented procedures	Internal number of implemented procedures.	Monthly
Training sessions	The number of training sessions.	Monthly
Internal EMS audit score	Internal audit system using REDU-CE-D methodological approach.	Monthly

To realize the EMS implementation, Adriafer created pilot action implementation grid as shown in Table 2.

Table 2: Implementation grid of the pilot site in railway transport.

Description	Timeline	Tools used	Output
EMS Pilot case definition and project perimeter	September 2025	Existing reports ISO 50001 Vendor demo	EMS technical description
EMS Procurement in accordance with local tender regulations	October 2025	Technical description Offer evaluation grid	Vendor selected
EMS Software implementation	January 2026	EMS software Cloud (Azure)	EMS customized
Define testing objectives and scope aligned with Pilot case definition	November 2025	Existing reporting Data sources Report list	Test objectives and scope
Define testing phase, processes & method (Issue identification, Classification & Priorisation, Verification...)	December 2025	Testing methodology	Phase and method defined
Define Test cases and scripts aligned with Pilot case definition	December 2025	Test case and script timelines	Cases and scripts defined
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Unit testing)	December 2025	EMS Cloud (Azure) XLS/CSV Adriafer data	Baseline data verified
Configuration of EMS registers and verification (Unit testing)	December 2025	EMS	Registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Unit testing)	December 2025	EMS Cloud (Azure) XLS/CSV Adriafer data	Data flows integrated and verified
Prepare testing environment and data for Integration testing	January 2026	EMS XLS/CSV Adriafer data	Test env ready
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Integration testing)	January 2026	EMS Cloud (Azure) XLS/CSV Adriafer data	Baseline data verified
Configuration of EMS registers and verification (Integration testing)	January 2026	EMS	Registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Integration testing)	January 2026	EMS Cloud (Azure)	Data flows integrated and verified
Training of operational staff on EMS use (data entry, monitoring, reporting)	January 2026	EMS	Staff trained
Prepare testing environment and data for System testing	January 2026	EMS XLS/CSV Adriafer data	Test env ready



Description	Timeline	Tools used	Output
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (System testing)	January 2026	EMS Cloud (Azure) XLS/CSV Adriafer data	Baseline data verified
Configuration of EMS registers and verification (System testing)	January 2026	EMS	Registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (System testing)	January 2026	EMS Cloud (Azure)	Data flows integrated and verified
Execution of pilot energy efficiency measures for System testing	March 2026	EMS	Actions executed
Monitoring of pilot performance against KPIs/EnPIs (energy consumption, kWh/m ² , CO ₂ reduction, noise reduction...) for System testing	March 2026	EMS	Performance monitored
User acceptance with validation of EMS standard reports compliance	April 2026	EMS	ISO 50001 compliance and user acceptance
Evaluation of EMS pilot guidelines implementation (procedures in procurement, maintenance, reporting...)	April 2026	EMS	Guidelines implementation evaluated
Compilation of final pilot report and recommendations for full roll-out	April 2026	EMS vs existing reports ISO 50001	Final report

3.1.3. Pilot Site Visit: Overview, Main Findings, and Lessons Learned

The railway transport pilot visit took place at the Port of Trieste, where Adriafer implemented a customized Environmental Management System (EMS) to support the decarbonization of rail shunting operations. The pilot combined the deployment of a digital monitoring framework with the gradual transition of the locomotive fleet from conventional diesel fuel to Hydrotreated Vegetable Oil (HVO). The EMS was designed to collect and validate operational and fuel consumption data, calculate key performance indicators (KPIs) for environmental performance, and generate periodic ESG reports, providing a structured basis for environmental performance monitoring and continuous improvement.

The pilot demonstrates that the transition to renewable fuel can be achieved without compromising operational performance. Between August 2025 and February 2026, the entire fleet of six shunting locomotives was successfully converted to 100% HVO, eliminating diesel consumption while maintaining stable overall fuel usage of approximately 1,800-2,000 liters per month.

The environmental benefits were significant. Carbon dioxide (CO₂) emissions were reduced by approximately 80%, decreasing from 3,112 kg CO₂ in August 2025 to around 570 kg CO₂ in February 2026. At the same time, important improvements in local air quality were achieved, with NO_x emissions reduced by approximately 55% and particulate matter (PM) concentrations reduced by approximately 60%. These results confirm that renewable fuel adoption contributes not only to climate change mitigation but also to improving air quality in port environments, where rail operations are closely integrated with other transport activities.

An equally important outcome of the pilot was the successful validation of the EMS workflow, which integrates operational data collection, environmental KPI calculation, reporting, and management review into a single decision-support framework. The system provides reliable environmental data for ESG reporting and supports compliance with ISO 14001 principles and evolving European sustainability reporting requirements.

The pilot site visit highlighted several key lessons learned. First, the replacement of conventional diesel with HVO represents a practical and immediately deployable decarbonization measure for



railway shunting operations, requiring minimal operational changes. Second, the greatest value is achieved when fuel transition is supported by a digital EMS capable of continuously monitoring environmental performance and providing verified data for decision-making.



3.2. Air transport

3.2.1. Air Transport case description

The purpose of the pilot action in Dubrovnik Airport is to demonstrate how innovative monitoring and reporting systems can significantly reduce the environmental impact of heating, ventilation and air conditioning (HVAC) systems at the airport. By introducing a new customized EMS, including real-time monitoring tools, the pilot will:

- enable real-time measurement and operations through SCADA,
- reduce emissions through optimization processes,
- provide operational evidence to customize the EMS package and
- deliver a replicable model for greener and more efficient energy management.

The pilot action focuses on the direct control and monitoring of the airport's HVAC system. The subject of the pilot project is the SEU (significant energy user) of six heat pumps. The scope covers:

- introduction of direct monitoring system on each heat pump,
- installation of sensors and digital interfaces to collect operational data (energy consumption) and
- integration of collected data into the customized EMS package and predictive DSS for continuous improvement.

3.2.2. EMS implementation

To test the EMS implementation at Dubrovnik airport, the company set technical and operational objectives to:

- Integrate energy monitoring tool (Schneider Power Monitoring Expert),
- Integrate EMS modules with the monitoring tool,
- Enable real-time monitoring of energy consumption and emissions,
- Deploy and test new operation procedures in real conditions,
- Reduce emissions through optimization,
- Engage maintenance staff in EMS routines, including maintenance logs and reporting and
- Provide validated data for EMS customizations and replication in air transport.

In order to test the EMS implementation, Dubrovnik airport chose indicators, as shown in Table 3.

Table 3: Indicators used in the air transport EMS implementation

Indicator	Description	Measurement frequency
Total Energy consumption [kWh]	Total energy consumption in the building area.	Monthly
SEU energy consumption [kWh]	Energy consumption of SEU (heat pumps).	Monthly
Passengers	/	Monthly
Temperature in building [°C]	Set temperature in the building area (seasonal effect).	Monthly



Indicator	Description	Measurement frequency
Temperature in open space [°C]	/	Monthly
Humidity [%]	Humidity measurements in the building.	Monthly
Implemented procedures	/	Pilot period
Updated documents	/	Pilot period
Training sessions	/	Pilot period

To realize the EMS implementation, Dubrovnik airport created pilot action implementation grid as shown in Table 4.

Table 4: Implementation grid of the pilot site in air transport.

Description	Timeline	Tools used	Output
EMS Pilot case definition and project perimeter	December 2025	Existing Microsoft files (Excel files) ISO requirements EMS software provider Demo	EMS technical Description
EMS Procurement in accordance with local tender regulations	October 2025	EMS Technical description EMS software offer's evaluation grid	EMS Vendor selection
EMS software implementation	January 2026	EMS Software, Microsoft Azure cloud service, EMS software provider project, Schneider Energy Power, Management SQL Data base	EMS Software customised
Define testing objectives and scope aligned with Pilot case definition	November 2025	Existing environmental reporting EMS software data resources specified, EMS software reports specified	EMS testing objectives and scope
Define testing phase, processes & method (Issue identification, Classification & Priorization, Verification...)	December 2025	EMS functionalities testing methodology	EMS testing phase, processes & methods
Define Test cases and scripts aligned with Pilot case definition	December 2025	EMS test cases and scripts definition methodology	EMS test cases and scripts methodology
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Unit testing)	December 2025	EMS Software Microsoft Azure cloud service XLS/CSV files with DBV environmental data	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (Unit testing)	December 2025	EMS Software	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Unit testing)	December 2025	EMS Software Microsoft Azure cloud service Schneider Energy Power Management SQL Data base	Data collected and verified
Prepare testing environment and data for Integration testing	January 2026	EMS software XLS/CSV files with DBV environmental data	Testing environment prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Integration testing)	January 2026	EMS software XLS/CSV files with DBV environmental data	Baseline energy and environmental data collected and verified



Description	Timeline	Tools used	Output
Configuration of EMS registers and verification (Integration testing)	January 2026	EMS Software	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Integration testing)	January 2026	EMS Software Microsoft Azure cloud service Schneider Energy Power Management SQL Data base	Data collected and verified
Training of operational staff on EMS use (data entry, monitoring, reporting)	January 2026	EMS Software	FBL operational staff trained
Prepare testing environment and data for System testing	January 2026	EMS Software, XLS/CSV files with DBV environmental data	Testing environment prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (System testing)	January 2026	EMS Software XLS/CSV files with DBV environmental data	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (System testing)	January 2026	EMS Software	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (System testing)	January 2026	EMS Software Microsoft Azure cloud service Shneider Energy Power Management SQL Data base	Data collected and verified
Execution of pilot energy efficiency measures for System testing	March 2026	EMS Software	Energy efficiency measures done
Monitoring of pilot performance against KPIs/EnPIs (energy consumption, kWh/m ² , CO ₂ reduction, noise reduction...) for System testing	March 2025	EMS Software	Pilot performance monitored
User acceptance with validation of EMS standard reports compliance	April 2026	EMS Software	EMS compliance with ISO 50001 and user acceptance
Evaluation of EMS pilot guidelines implementation (procedures in procurement, maintenance, reporting...)	April 2026	EMS Software	EMS pilot guideline implementation evaluated
Compilation of final pilot report and recommendations for full roll-out	April 2026	EMS Software compared with Existing reports (Excel files...) and ISO 50001 Requirements	Final report

3.2.3. Pilot Site Visit: Overview, Main findings, and Lessons learned

The air transport pilot visit took place at Dubrovnik Airport (DBV) with the objective of improving energy efficiency through the deployment of a customized Energy and Environmental Management System (EMS). The implementation followed a structured three-phase approach, beginning with the adoption of the ISO 50001 energy management framework, followed by the upgrade of the existing Schneider Power Monitoring Expert (PME) platform, and concluding with the deployment of a customized EMS integrating energy monitoring, environmental data analysis, KPI evaluation, and reporting.

The pilot focuses on the airport's HVAC infrastructure, identified as the most significant energy user (SEU), with six heat pumps included in the monitoring system. The EMS integrates automated energy consumption data from Schneider PME with passenger traffic, weather conditions, solar power generation, and other operational parameters, enabling a comprehensive analysis of energy demand and supporting data-driven decision making. The platform provides interactive dashboards, trend analysis, forecasting functions, and semi-automated reporting to support both operational management and ISO 50001 compliance.



The implementation demonstrated that integrating existing monitoring infrastructure with a customized EMS significantly improves operational visibility and energy management. By January 2026, the system enabled continuous monitoring of electricity consumption, HVAC performance, environmental conditions, and passenger flows. As electricity accounts for approximately 79% of the airport's total primary energy consumption, the pilot identified HVAC optimization as the most effective measure for reducing energy demand. Additional improvements included optimization of heat pump control parameters, integration of all six heat pumps into the centralized monitoring system, and SCADA upgrades to enhance system supervision.

The pilot site visit also highlighted the flexibility of the customized EMS compared with standard commercial monitoring solutions. Beyond energy monitoring, the platform supports integrated data analysis, KPI tracking, forecasting, management reporting, and ISO 50001 documentation. Future developments will focus on further automation of data collection, integration with airport SQL databases, improved reporting capabilities, and enhanced user customization, reducing manual data handling and minimizing the risk of human error.



3.3. Urban transport

3.3.1. Urban Transport case description

The objective of the pilot action is to examine and assess the energy efficiency of the bus terminal building and the Górka Narodowa Park and Ride (P+R) parking facility in Kraków as a model example of modern transport infrastructure. The project will verify how innovative technologies and monitoring systems can reduce energy consumption and emissions associated with the operation of such facilities.

Through the implementation of measurement and analytical tools, the pilot will enable:

- real-time monitoring of electricity, heating, and auxiliary systems consumption;
- analysis of the impact of applied technical solutions (such as LED lighting, ventilation and air-conditioning systems) on the facility's energy balance;
- identification of potential energy savings and emission reductions across the building's life cycle and
- provision of guidelines and best practices for the design and operation of future bus terminals and P+R facilities in Kraków and other European cities.

3.3.2. EMS implementation

The pilot will encompass a comprehensive set of activities aimed at assessing and optimizing the energy efficiency of the facility. Within the project, the following steps will be implemented:

- 1. Identification of areas for energy optimization:**
 - Analysis of the building infrastructure and technical installations (lighting, ventilation, air conditioning, heating systems, elevators, charging stations for electric vehicles).
 - Identification of elements with the highest potential for reducing energy consumption.
- 2. Analysis of energy consumption based on EMS data:**
 - Collection of data on electricity and heat consumption.
 - Analysis of consumption trends and seasonal fluctuations.
 - Definition of energy efficiency indicators.
- 3. Implementation of monitoring tools and anomaly detection systems:**
 - Continuous monitoring of installation performance.
 - Automatic detection of inefficiencies, energy losses, and deviations from standards.
 - Remote access to data and real-time reports.
- 4. Report on energy consumption and EMS performance**
 - Preparation of a report summarizing monitoring and analysis results.
 - Identification of specific recommendations for improving energy efficiency.
 - Evaluation of the implemented EMS system's performance.
- 5. Report on innovative technologies and solutions supporting energy efficiency**



- Analysis of available technologies (e.g., photovoltaics, heat recovery systems, intelligent lighting and climate management systems).
- Recommendations for integrating new solutions with the existing EMS.
- Identification of possible development directions for future investments in such facilities.

In order to test the EMS implementation, GMK chose indicators, as shown in Table 5.

Table 5: Indicators used in the urban transport EMS implementation

Indicator	Description	Measurement frequency
Energy consumption [kWh]	Total energy consumption in the building area.	Monthly
Water consumption [m ³]	Water consumption in the building area.	Monthly
Tickets	Number of passengers.	Monthly
Travels [h]	Hours of service	Monthly
Renewable energy used [%]	/	Monthly
NO ₂ concentration [µg/m ³]	/	Monthly

To realize the EMS implementation, GMK created pilot action implementation grid as shown in Table 6.

Table 6: Implementation grid of the pilot site in urban transport.

Description	Timeline	Tools used	Output
EMS Pilot case definition and project perimeter	September 2025	Existing reports	EMS technical description
EMS Procurement in accordance with local tender regulations	October 2025	EMS technical description, EMS software offer's evaluation	EMS vendor selection
EMS Software implementation	January 2026	EMS software EMS software provider project managements SQL database	EMS software customized
Define testing objectives and scope aligned with Pilot case definition	November 2025	Existing environmental reporting EMS software data sources specified EMS software report specified	EMS testing objectives and scope
Define testing phase, processes & method (Issue identification, Classification & Priorisation, Verification...)	December 2025	EMS functionalities testing methodology	EMS testing phase, processes and methods
Define Test cases and scripts aligned with Pilot case definition	December 2025	EMS test cases and scripts Definition methodology	EMS test cases and scripts methodology
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Unit testing)	December 2025	XLS/CSV files	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (Unit testing)	December 2025	EMS software XLS/CSV files	EMS registers configured and verified



Description	Timeline	Tools used	Output
Integration of pilot data flows in case of automated data collection and verification (Unit testing)	December 2025	EMS software XLS/CSV files	Data collected and verified
Prepare testing environment and data for Integration testing	January 2026	EMS software XLS/CSV files	Testing environmental prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Integration testing)	January 2026	EMS Software XLS/CSV files	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (Integration testing)	January 2026	EMS software	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Integration testing)	January 2026	EMS software XLS/CSV files	Data collected and verified
Training of operational staff on EMS use (data entry, monitoring, reporting)	January 2026	EMS software	GMK operational staff trained
Prepare testing environment and data for System testing	January 2026	EMS software XLS/CSV files	Testing environment prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (System testing)	January 2026	EMS software XLS/CSV files	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (System testing)	January 2026	EMS software	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (System testing)	January 2026	EMS software XLS/CSV files	Data collected and verified
Execution of pilot energy efficiency measures for System testing	March 2026	EMS software	Energy efficiency measures done
Monitoring of pilot performance against KPIs/EnPIs (energy consumption, kWh/m ² , CO ₂ reduction, noise reduction...) for System testing	March 2026	EMS software	Pilot performance monitored
User acceptance with validation of EMS standard reports compliance	April 2026	EMS software	EMS compliance with user acceptance
Evaluation of EMS pilot guidelines implementation (procedures in procurement, maintenance, reporting...)	April 2026	EMS software	EMS pilot guideline implementation evaluated
Compilation of final pilot report and recommendations for full roll-out	April 2026	EMS software compared with existing reports (excel files)	Final report

3.3.3. Pilot Site Visit: Overview, Main findings, and Lessons learned

The urban transport pilot visit took place at the City of Kraków at the Park & Ride (P+R) Górka Narodowa facility, including its bus terminal, with the objective of improving energy efficiency through the deployment of an Energy Management System (EMS) and advanced energy performance analysis. The pilot combines real-time energy monitoring with building simulation tools to identify optimization opportunities and develop practical recommendations for future investments in sustainable urban transport infrastructure.

The first phase of the pilot focused on analysing the facility's design documentation, conducting on-site inspections, and identifying the main energy consumers. In addition, a Smart Readiness Indicator (SRI) assessment was conducted to evaluate the building's readiness for smart energy management and identify opportunities to improve energy efficiency, user comfort, and energy flexibility. Based on these activities, the key areas requiring optimization were identified, and the selection of an appropriate EMS solution was initiated.



The implementation phase included installing energy-monitoring sensors and collecting operational data through the EMS. These data are combined with a detailed digital building model developed in DesignBuilder, enabling year-round simulations of energy performance and occupant comfort. The integration of real operational data with simulation models allows different optimization scenarios to be evaluated before implementation and supports evidence-based decision-making.

The pilot aims to use the EMS for continuous monitoring of energy consumption, detection of operational anomalies, and identification of potential energy-saving measures. Based on the collected data and simulation results, comprehensive reports will be prepared, including energy performance analyses, SRI assessment results, and practical recommendations for improving the energy management system. The project will also evaluate innovative technologies such as building automation, photovoltaic systems, battery storage, heat pumps, thermal storage, and low-emission building materials to assess their technical and economic feasibility.

Overall, the pilot visit demonstrated how combining real-time EMS monitoring with digital building modelling can support more efficient management of urban transport infrastructure. The expected outcomes include a better understanding of energy flows within Park & Ride facilities, improved energy performance and user comfort, and practical guidelines for future modernization projects. The developed methodology provides a transferable approach to support energy-efficient, climate-neutral urban mobility in Kraków and other European cities.



3.4. Waterway transport

3.4.1. Waterway transport case description

As a pilot activity, FBL decided to implement ISO 50001 at its port (Freeport of Budapest), which affects property development, operations, and rental activities.

The introduction of ISO 50001 is fundamentally concerned with establishing a systematic framework through which organizations can enhance their energy performance in a measurable, verifiable, and sustainable manner. By adopting this international standard, institutions embed energy efficiency into their strategic and operational processes, thereby moving beyond ad hoc initiatives towards a culture of continuous improvement. The framework is grounded in the Plan-Do-Check-Act (PDCA) cycle, ensuring that energy objectives are not only clearly defined but also regularly monitored, reviewed, and refined, considering empirical evidence. In doing so, ISO 50001 facilitates both compliance with regulatory requirements and the pursuit of broader environmental and economic objectives, such as reducing greenhouse gas emissions, improving competitiveness through cost savings, and demonstrating corporate responsibility. Its successful implementation thus represents not merely a technical adjustment but a transformative organizational commitment to energy stewardship and long-term sustainability.

The purpose of this pilot is to demonstrate how targeted energy management measures can reduce the environmental impact of waterway-related operations at Freeport. By introducing a customized EMS framework tailored to port activities, combined with data analytics, the pilot focuses exclusively on the share of energy consumption directly influenced by FBL, as more than 90% of total consumption is attributable to tenants and therefore cannot be subject to reduction commitments. Within this limited but relevant scope, the pilot will set it as a goal:

- to reduce energy use in heating systems by 8%;
- to achieve a 5% reduction in outdoor lighting consumption;
- to reduce energy consumption in transport activities (fleet vehicles) by 5%;
- provide operational evidence to adapt the EMS package specifically for waterway transport and port-related energy systems; and
- deliver a replicable model for greener and more efficient port and waterway operations that can be transferred across Central European inland ports.

3.4.2. EMS implementation

Technical and operational objectives regarding EMS implementation at the Freeport are to:

- Integrate customized EMS modules into Freeport operations, focusing only on the share of energy use directly controlled by FBL;
- Gaining complete visibility of energy use through all 12 electricity and 7 gas Points of Delivery (PODs);
- Identifying the subset of PODs under direct FBL influence, representing about 10% of total consumption, where measurable energy reduction targets can be introduced;
- Implementing targeted reductions in heating (-8%), outdoor lighting (-5%), and transportation (-5%);
- Establishing a toolkit for monitoring and analysis that can also be shared with other partners;
- Enable real-time monitoring of consumption at all 12 electricity and 7 gas PODs;



- Reduce energy consumption in heating, outdoor lighting, and transport activities according to defined targets;
- Engage operational staff in EMS routines, including data validation, maintenance logs, and reporting; and
- Provide validated data for EMS customization and replication in other inland ports, while acknowledging that tenant-driven consumption cannot be included.

In order to test the EMS implementation, FBL chose indicators, as shown in Table 7.

Table 7: Indicators used in the waterway transport EMS implementation

Indicator	Description	Measurement frequency
Outdoor lighting consumption [kWh]	Consumption of electrical energy caused by outdoor lighting.	Monthly
Natural gas consumption [Sm ³]	Natural gas consumption made by operations.	Monthly
Gasoline consumption [l]	Gasoline consumption made by operations.	Monthly
Diesel consumption [l]	Diesel consumption made by operations.	Monthly
12 Point of Delivery (PODs) of electricity energy consumption [kWh]	PODs of electricity energy consumption under direct FBL influence (represents about 10% of total consumption where measurable energy reduction targets can be introduced).	Monthly
7 PODs of natural gas consumption [m ³]	PODs of natural gas consumption under direct FBL influence (represents about 10% of total consumption where measurable energy reduction targets can be introduced).	Monthly
Open space average temperature [°C]	/	Monthly
Heating Degree Days (HDD)	Demand for energy needed to heat a building (base temperature set to 15,5°C)	Monthly

To implement the EMS, FBL created the pilot action implementation grid shown in Table 8.

Table 8: Implementation grid of the pilot site in waterway transport.

Description	Timeline	Tools used	Output
EMS Pilot case definition and project perimeter	May 2025	Existing Microsoft files (Word, Excel)	EMS technical Description
EMS Procurement in accordance with local tender regulations	June 2025	Selection of EMS software/subcontractor based on the data to be measured	EMS Vendor selection
EMS implementation	October 2025	EMS Software Microsoft Azure cloud service EMS Software provider project management method Zöldterv Kft. Energy Planner Management SQL Data base	EMS Software customised



Description	Timeline	Tools used	Output
Define testing objectives and scope aligned with Pilot case definition	October 2025	Content, format, and specifications of EMS data	EMS testing objectives and scope
Define testing phase, processes & method (Issue identification, Classification & Priorisation, Verification...)	November 2025	EMS functionalities testing methodology	EMS testing phase, processes & methods
Define Test cases and scripts aligned with Pilot case definition	November 2025	EMS test cases and scripts definition methodology	EMS test cases and scripts methodology
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Unit testing)	October 2025	EMS Software XLS/CSV files with FBL environmental data ISO50001 baseline	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (Unit testing)	November 2025	EMS Software ISO50001 baseline and SEUs, EnPI	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Unit testing)	November 2025	EMS Software Microsoft Azure cloud service Zöldterv Kft. Energy Planner Management SQL Data base	Data collected and verified
Prepare testing environment and data for Integration testing	December 2025	XLS/CSV files	Testing environment prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (Integration testing)	January 2026	EMS Software XLS/CSV files with FBL environmental data ISO50001 baseline	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (Integration testing)	January 2026	EMS Software ISO50001 baseline and SEUs, EnPI	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (Integration testing)	January 2026	EMS Software Microsoft Azure cloud service Zöldterv Kft. Energy Planner Management SQL Data base	Data collected and verified
Training of operational staff on EMS use (data entry, monitoring, reporting)	January 2026	EMS Software	FBL operational staff trained
Prepare testing environment and data for System testing	January 2026	XLS/CSV files	Testing environment prepared
Collection of baseline energy and environmental data (electricity, HVAC, waste, water, CO ₂) and verification of data collection (System testing)	January 2026	EMS Software XLS/CSV files with FBL environmental data ISO50001 baseline	Baseline energy and environmental data collected and verified
Configuration of EMS registers and verification (System testing)	January 2026	EMS Software ISO50001 baseline and SEUs, EnPI	EMS registers configured and verified
Integration of pilot data flows in case of automated data collection and verification (System testing)	January 2026	EMS Software Microsoft Azure cloud service Zöldterv Kft. Energy Planner Management SQL Data base	Data collected and verified
Execution of pilot energy efficiency measures for System testing	March 2026	EMS Software	Energy efficiency measures done
Monitoring of pilot performance against KPIs/EnPIs (energy consumption, kWh/m ² , CO ₂ reduction, noise reduction...) for System testing	April 2026	EMS Software EnPI	Pilot performance monitored
User acceptance with validation of EMS standard reports compliance	April 2026	EMS Software	EMS compliance with ISO 50001 and user acceptance
(Self) Evaluation of EMS pilot implementation	April 2026	EMS Software	EMS pilot guideline implementation evaluated



Description	Timeline	Tools used	Output
Compilation of final pilot report and recommendations for full roll-out	April 2026	EMS Software compared with Existing reports (Excel files...) and ISO 50001 Requirements	Final report

3.4.3. Pilot Site Visit: Overview, Main findings, and Lessons learned

The waterway transport pilot visit took place at the Freeport of Budapest (Csepel) with the objective of improving port-level energy management through the implementation of an ISO 50001-based Energy Management System (EMS). The pilot focused on establishing a structured framework for collecting, analysing, and managing energy data to support more efficient port operations and improve the quality and transparency of energy reporting.

The main drivers for implementing the EMS were the need for accurate energy data, increasing ESG reporting requirements, and the growing complexity of energy management within the port. As the port continues to expand with new energy-intensive activities, such as electric vehicle charging infrastructure and data centres, a centralized EMS became essential for monitoring energy consumption and supporting strategic planning. A particular challenge was that more than 90% of the port's energy consumption is associated with tenant activities, limiting the port operator's direct control over energy use and highlighting the importance of data aggregation and collaboration with tenants.

The pilot followed an ISO 50001 methodology, including the development of an energy policy, definition of the data collection structure, implementation of a customized EMS adapted to the port environment, and continuous data collection and analysis. During the implementation phase, the EMS was integrated with the existing monitoring infrastructure, historical energy data were imported into the system, and ISO 50001 certification was successfully achieved. The pilot also included validation of the EMS during on-site testing and refinement of the toolkit based on operational experience.

The pilot demonstrated that the customized EMS significantly improves the quality, consistency, and transparency of energy data while providing a reliable basis for performance monitoring and decision support. The system enables continuous analysis of energy consumption, supports the identification of optimization opportunities, and facilitates ESG reporting and compliance with ISO 50001 requirements. Current activities focus on validating collected data, monitoring system performance, and continuously improving the EMS based on measured operational results.

Overall, the pilot confirmed that an ISO 50001 - based EMS provides an effective approach for managing energy performance in complex port environments, even where direct operational control is limited. By improving data quality, integrating existing monitoring systems, and supporting evidence-based decision-making, the developed solution offers a scalable and transferable model for other inland ports seeking to optimize energy consumption, strengthen environmental management, and support the transition towards more sustainable waterway transport.



4. Pilot Evaluation results

4.1. Railway transport

4.1.1. Interpretation and analysis of KPIs

The KPI assessment provides an overview of the environmental and operational performance achieved during the implementation of the Environmental Management System (EMS) within the railway transport sector. The selected indicators evaluate not only the environmental benefits of the implemented measures but also their impact on operational performance and the maturity of EMS implementation.

The overall performance indicators shown in Figure 1 demonstrate encouraging progress towards the environmental objectives established at the beginning of the implementation period. The combination of Carbon Intensity, HVO Adoption Rate and EMS Compliance Index indicates that operational environmental performance has improved considerably, although the organisational implementation of EMS is still developing. A Carbon Intensity of approximately 6 kg CO₂ per operating hour, together with an HVO Adoption Rate of 52.88%, confirms that renewable fuel has become the primary energy source for railway shunting operations. At the same time, the EMS Compliance Index of 22.5% suggests that additional efforts are still required to fully integrate EMS procedures into everyday operational and management activities.

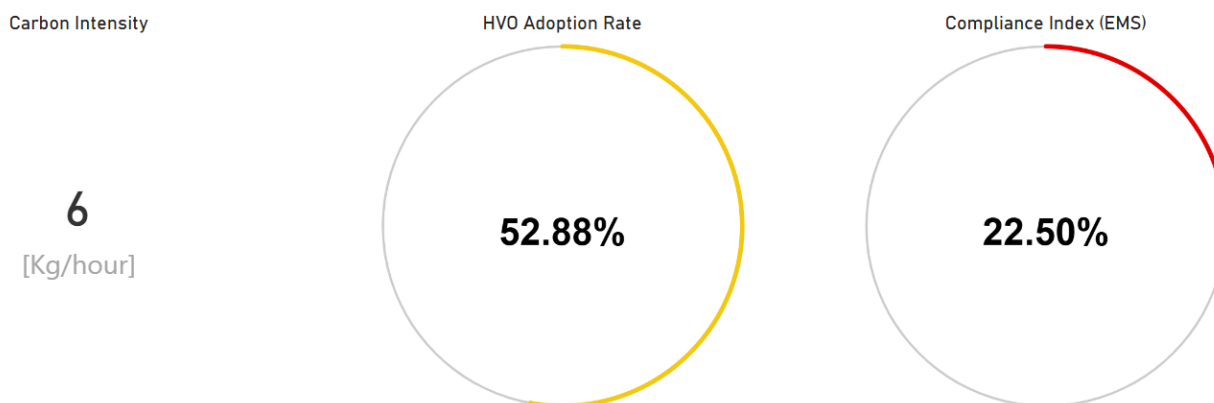


Figure 1: Carbon intensity, HVO adoption rate and compliance index (EMS) over the monitoring period - railway transport

The improvements observed in the overall KPIs are closely related to the transition from conventional diesel fuel towards Hydrotreated Vegetable Oil (HVO). As shown in Figure 2, renewable fuel already accounts for more than half of the total fuel consumption, representing an important milestone in reducing dependence on fossil fuels. The monthly fuel consumption profile shown in Figure 3 further demonstrates that this transition was implemented progressively throughout the reporting period, with diesel consumption steadily declining while HVO usage increased accordingly.

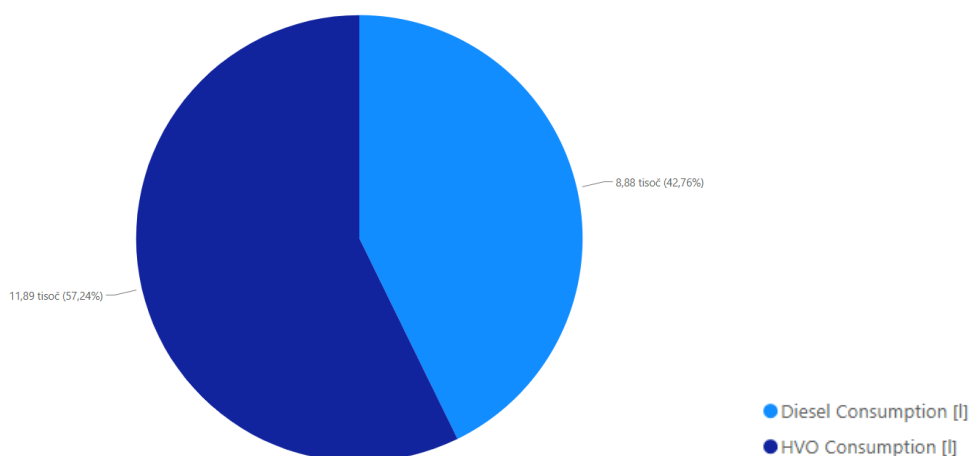


Figure 2: Diesel and HVO consumption over the monitoring period - railway transport

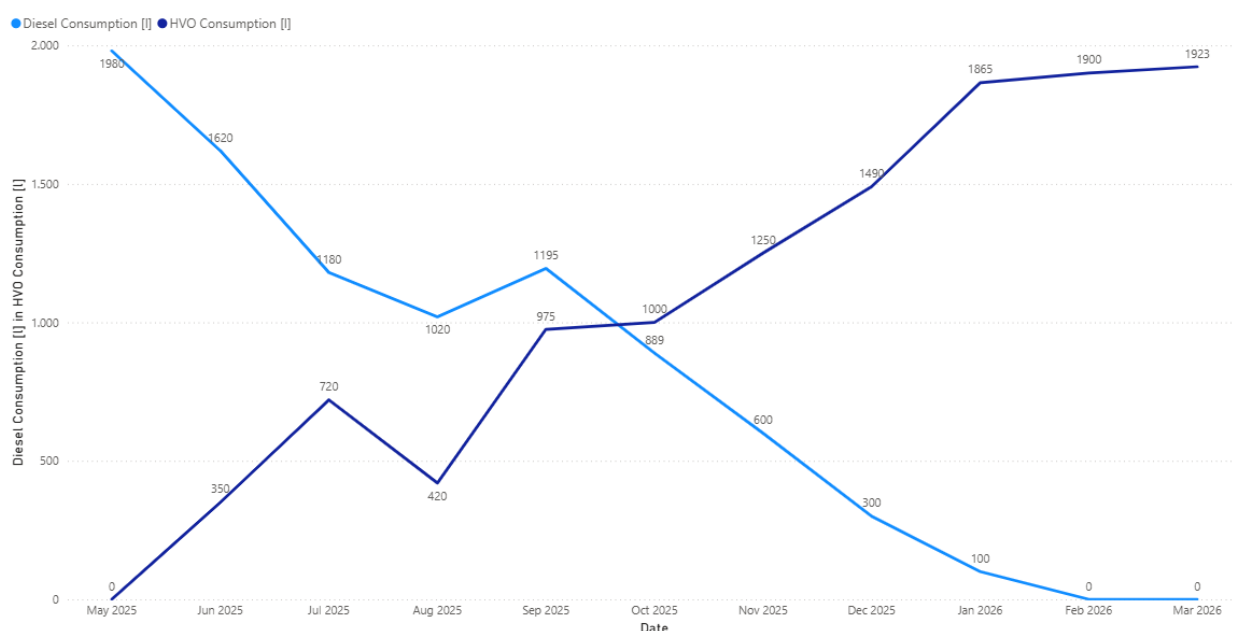


Figure 3: Comparison of diesel and HVO consumption over the monitoring period - railway transport

The environmental benefits of this transition become particularly evident when analyzing the estimated greenhouse gas emissions. As presented in Figure 4, estimated CO₂ emissions decreased continuously throughout the evaluation period, falling from approximately 5.3k tones to less than 0.6k tones. This substantial reduction confirms that the adopted fuel strategy has translated directly into measurable environmental improvements and demonstrates the effectiveness of the implemented EMS measures in reducing the carbon footprint of railway transport operations.

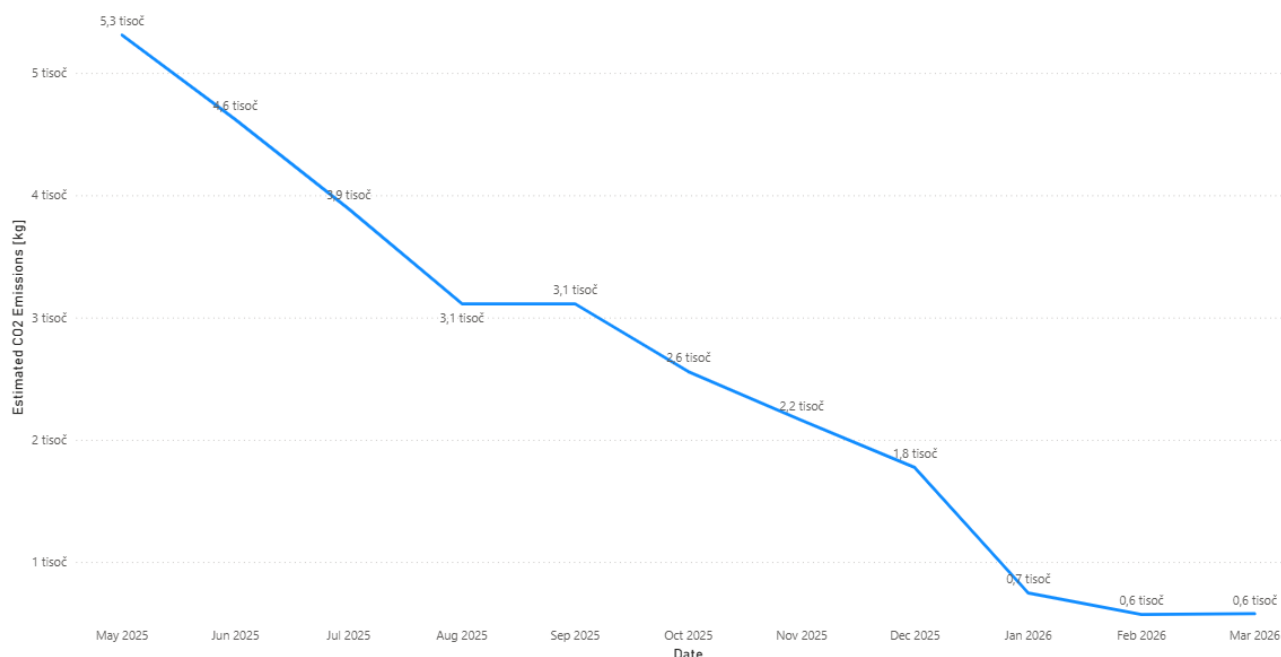


Figure 4: Estimated CO₂ emissions over the monitoring period - railway transport

Importantly, these environmental improvements were achieved without negatively affecting operational performance. The number of wagons moved, presented in Figure 5, remained relatively stable throughout the reporting period despite seasonal fluctuations in transport demand. Furthermore, the relationship between wagon movements and shunting hours shown in Figure 6 indicates that operational efficiency remained consistent during the implementation period. The available resources continued to be effectively utilised while environmental measures were gradually introduced into daily operations.



Figure 5: Number of wagons moved over the monitoring period - railway transport

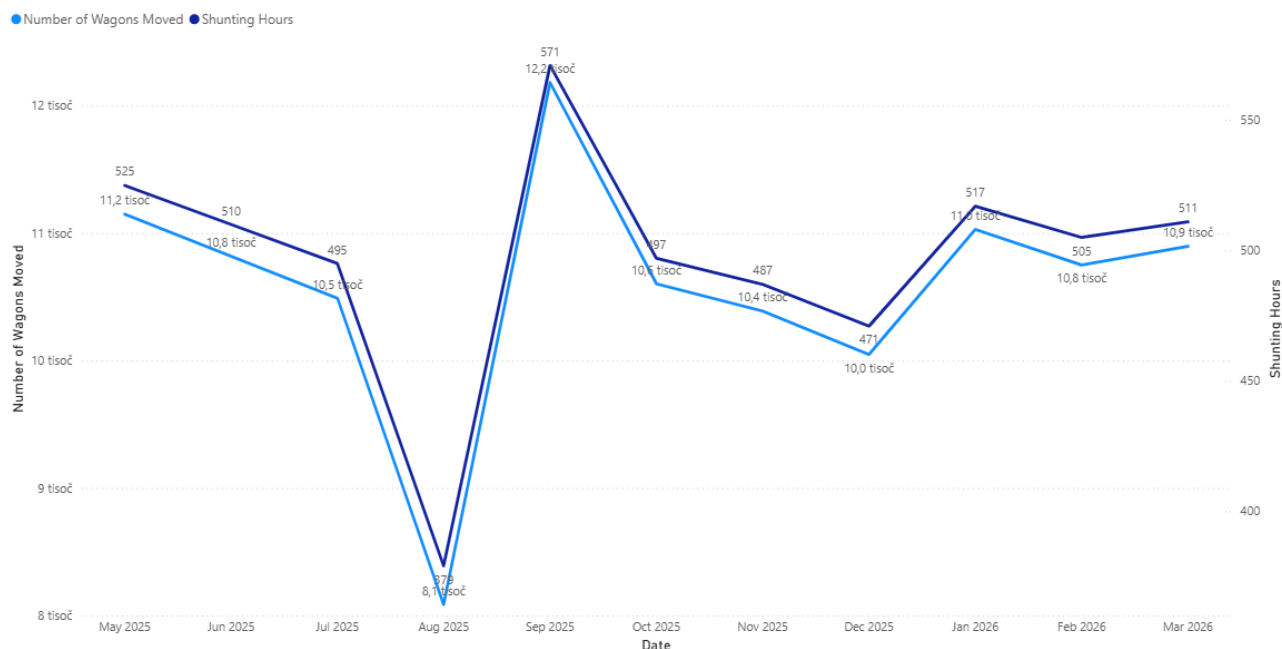


Figure 6: Comparison of wagons moved and shunting hours over the monitoring period - railway transport

While the operational KPIs demonstrate clear environmental improvements, the organisational indicators provide additional insight into the maturity of EMS implementation. The Average Internal EMS Audit Score presented in Figure 7 indicates that the EMS is progressing through its implementation phase but has not yet reached full operational maturity. This observation is consistent with the Percentage of EMS Integration into Operations shown in Figure 8, which shows a steady increase, indicating that environmental management practices are becoming increasingly embedded in routine operational activities. Together, these indicators suggest that the organisation has established a solid foundation for EMS implementation, although further development of internal procedures, management review and employee involvement will be required to achieve full compliance.

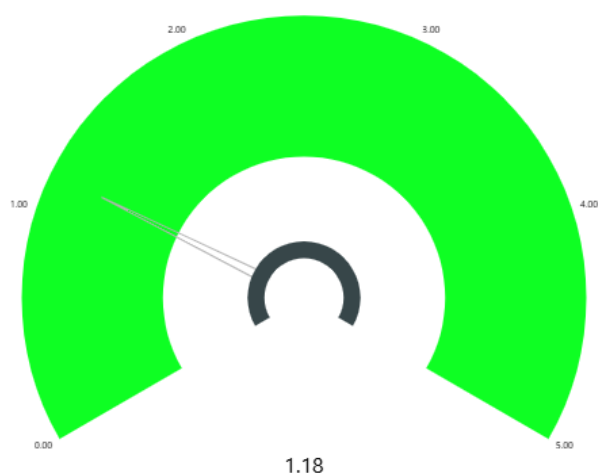


Figure 7: Average internal EMS audit score over the monitoring period - railway transport

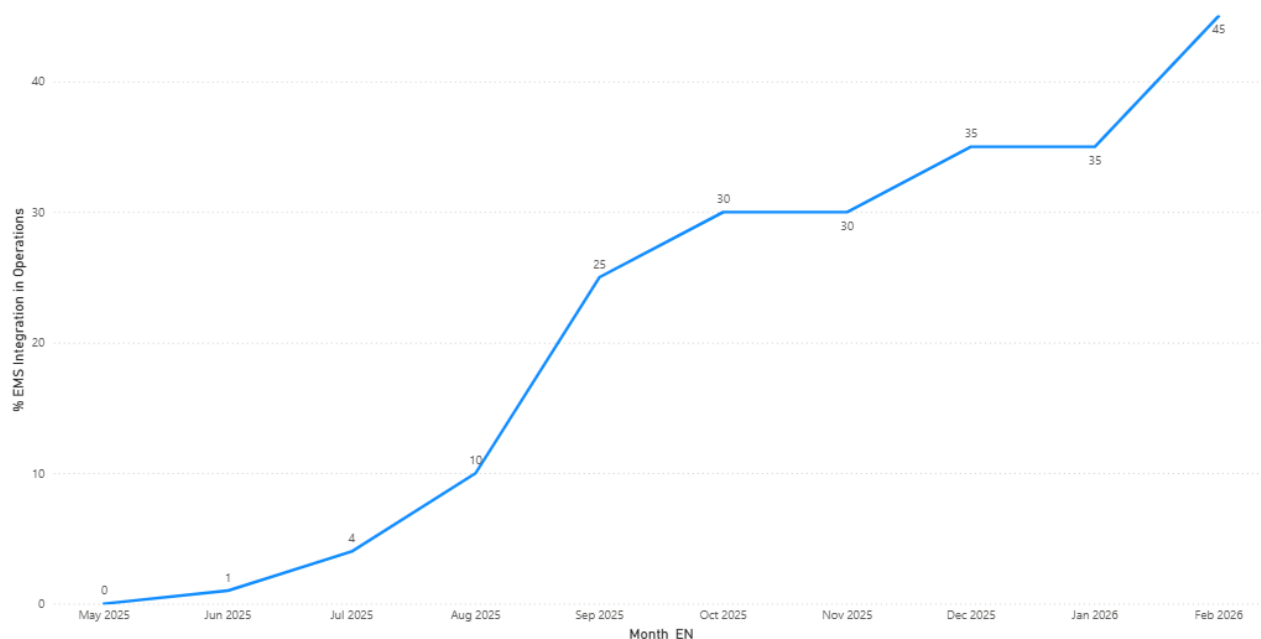


Figure 8: Percentage of EMS integration in operations over the monitoring period - railway transport

The environmental benefits of the implemented measures extend beyond greenhouse gas emissions. As illustrated in Figure 9, concentrations of NO_x, particulate matter (PM) and dust all decreased during the evaluation period, confirming improvements in local air quality alongside reductions in carbon emissions. These results demonstrate that the transition towards renewable fuel contributes simultaneously to climate change mitigation and to reducing the environmental impact on the surrounding operational environment.

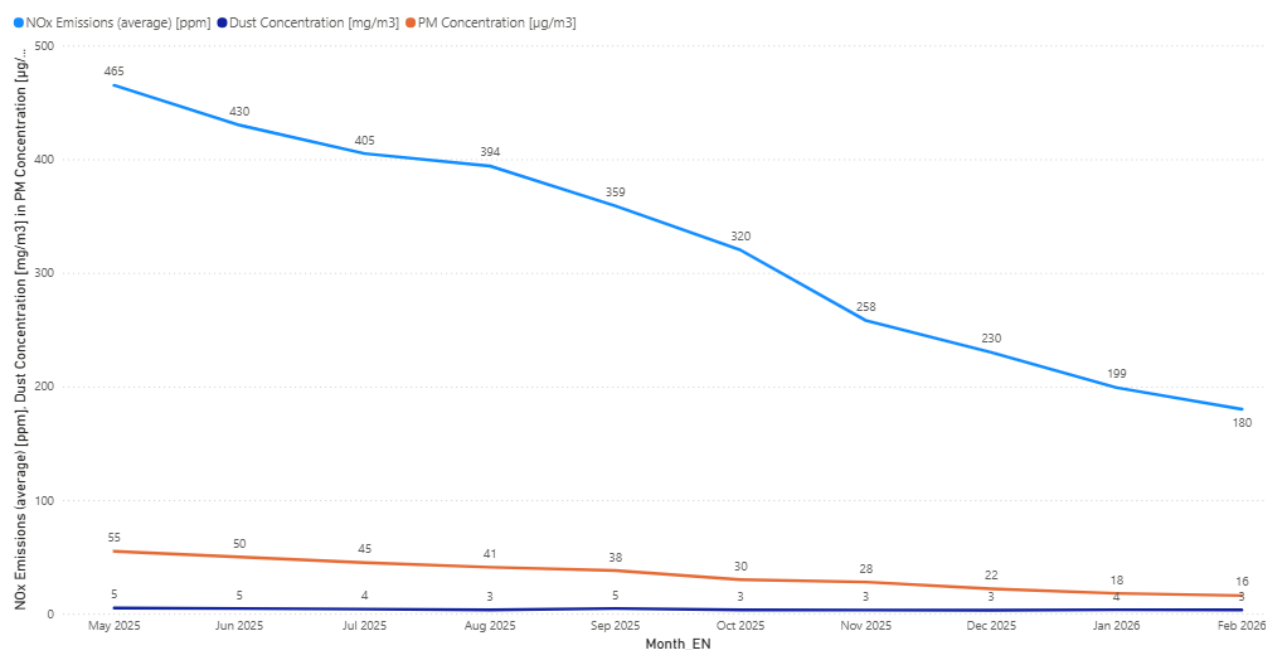


Figure 9: NO_x emissions, dust concentration and PM concentration over the monitoring period - railway transport



Unlike the air quality indicators, the Average Noise Level presented in Figure 10 remained primarily dependent on operational intensity. Variations in noise levels generally corresponded with changes in shunting activity rather than with the implementation of environmental measures. Nevertheless, no significant long-term increase was observed during the reporting period, indicating that the introduction of EMS measures has not resulted in additional acoustic impacts on railway operations.

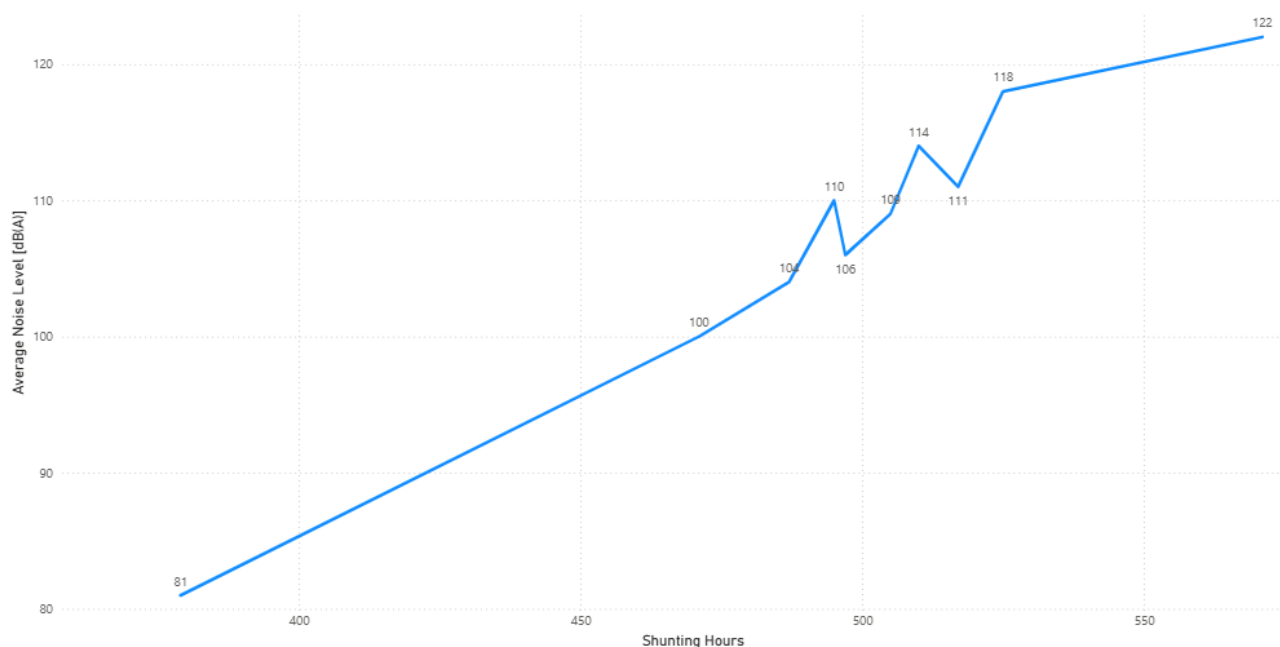


Figure 10: Average noise level in correlation with shunting hours over the monitoring period - railway transport

Overall, the KPI assessment demonstrates that the implementation of the EMS has produced measurable environmental benefits while maintaining stable operational performance. The transition towards HVO fuel has significantly reduced greenhouse gas emissions and improved local air quality without compromising transport efficiency. At the same time, organisational indicators confirm that EMS implementation is progressing steadily, although continued efforts should focus on strengthening internal governance, audit processes and system integration to ensure the long-term sustainability of the achieved improvements.

4.1.2. Comparison against baseline

This chapter presents a comparison of the selected Key Performance Indicators (KPIs) before and during the implementation of the EMS in the railway transport pilot. The analysis includes the following KPIs, all normalized by the **number of wagons moved**:

- Diesel consumption,
- Total fuel consumption,
- NOx emissions,
- PM concentration,
- Dust concentration,
- HVO consumption and



- CO₂ emissions.

As described, all selected KPIs were normalized by the number of wagons moved to eliminate the influence of operational activity on the results. This normalization enables a more objective comparison of the environmental performance before and during the EMS implementation.

All data presented in this chapter refer to the year 2025. As shown in the following figures, Adriafer started the implementation of the EMS in August 2025. Therefore, the period from May to July 2025 represents the baseline before the EMS implementation, while the period from August to October 2025 corresponds to the implementation phase.

In the following figures, the “Forecast” represents the calculated baseline value, i.e. the expected KPI value after normalization by the number of wagons moved. The “During implementation” values represent the actual measured KPIs during the EMS implementation period. Comparing these values makes it possible to assess whether the implemented EMS measures contributed to improvements in the selected environmental performance indicators beyond those expected from operational activity alone.

4.1.2.1. Fuel consumption indicators

The first group of indicators evaluates whether the operational measures introduced within the EMS pilot contributed to improved fuel efficiency. According to the objectives of the Pilot Action, fuel savings were expected to result primarily from operational improvements such as eco-driving practices, reduced locomotive idling, improved shunting planning, and the increased use of renewable HVO fuel. Figure 11 presents the comparison of normalized diesel consumption before the implementation, the forecast value, and the measured value during the EMS implementation.

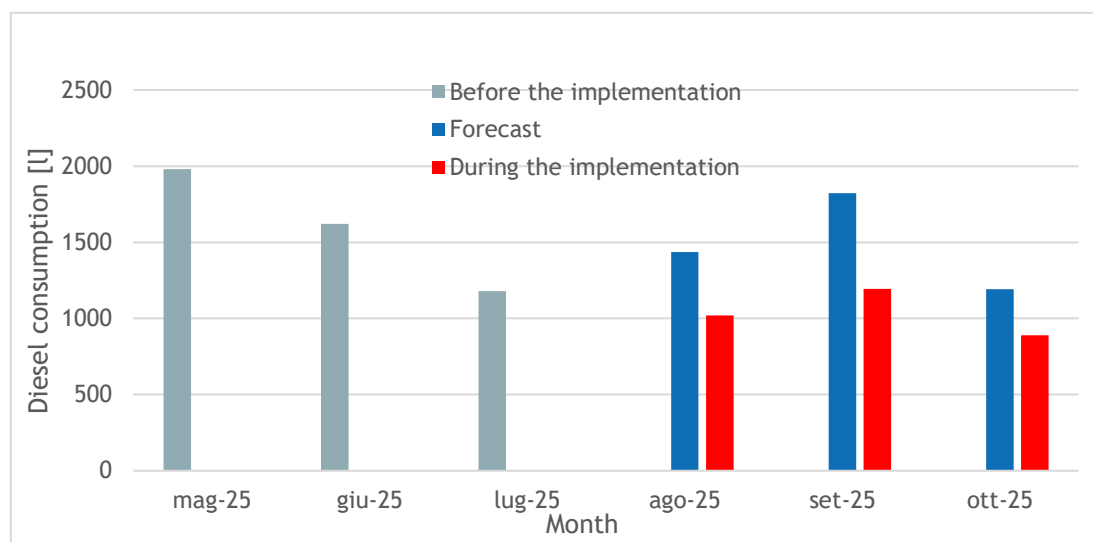


Figure 11: Normalized diesel consumption - railway transport

The measured diesel consumption (shown in Figure 11) remained consistently below the forecast values throughout the implementation period. This reduction suggests that the operational measures introduced within the Pilot Action, particularly eco-driving practices, reduced locomotive idling, and improved planning of shunting operations, contributed to lower diesel demand than expected from operational activity alone.



While the previous indicator demonstrates a reduction in diesel consumption, the following analysis examines whether conventional diesel was partially replaced by renewable HVO fuel. Figure 12 presents the comparison of normalized HVO consumption before and during the EMS implementation.

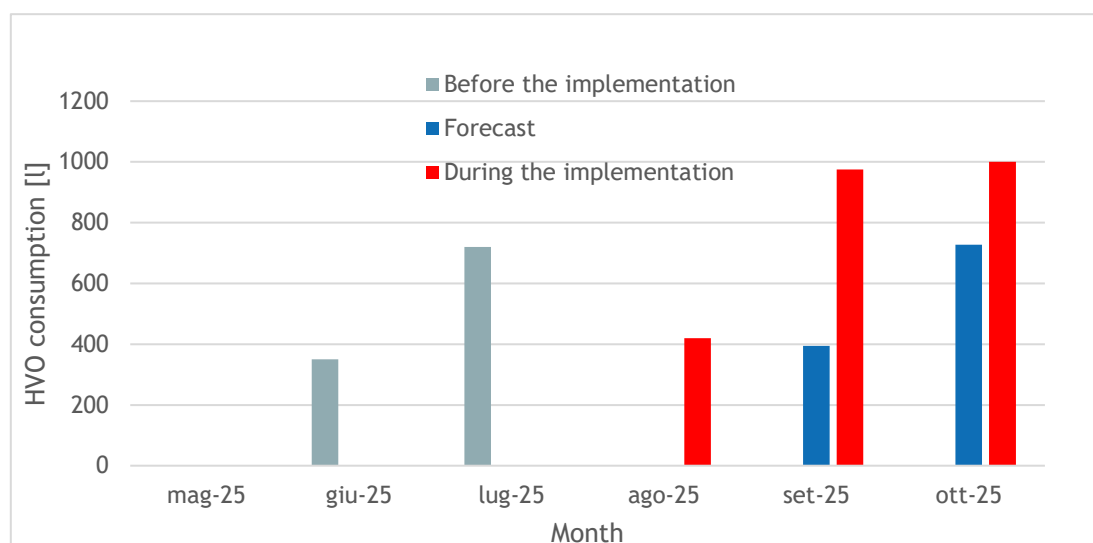


Figure 12: Normalized HVO consumption - railway transport

Unlike diesel consumption, HVO consumption (as shown in Figure 12) increased during the implementation period and exceeded the forecast values in all observed months. The most pronounced increase was recorded in September and October, indicating a gradual transition towards greater utilization of renewable fuel. This result is consistent with one of the main objectives of the Pilot Action, namely to reduce dependence on conventional diesel while increasing the use of lower-carbon fuel alternatives.

The previous two indicators describe the individual fuel types. The following figure, therefore, evaluates their combined impact on the total fuel consumption. Figure 13 presents the comparison of normalized total fuel consumption before and during the EMS implementation.

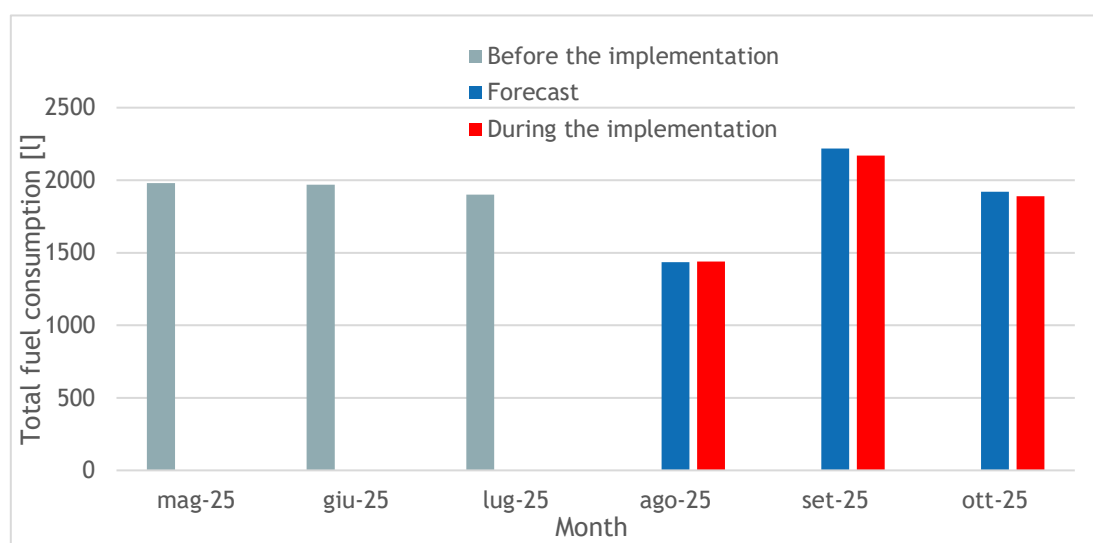


Figure 13: Normalized total fuel consumption - railway transport



The results show that total fuel consumption remained close to the forecast values during the implementation period, with a slight reduction observed in September and October. Although the overall fuel demand changed only moderately, the fuel mix shifted towards increased HVO utilization and reduced diesel consumption. This indicates that the EMS measures focused not only on reducing fuel demand but also on improving the environmental profile of railway shunting operations.

4.1.2.2. Emission indicators

Changes in fuel consumption are expected to directly influence the environmental performance of railway operations. The following indicators, therefore, assess whether the operational improvements introduced within the EMS pilot also resulted in lower emissions.

As shown in Figure 14, the measured CO₂ emissions remained significantly below the forecast values throughout the implementation period. The greatest improvement was observed in September, corresponding to the largest reduction in diesel consumption and increased HVO utilization. These findings indicate that the implemented operational measures successfully reduced greenhouse gas emissions and contributed to the decarbonization objectives of the Pilot Action in railway transport.

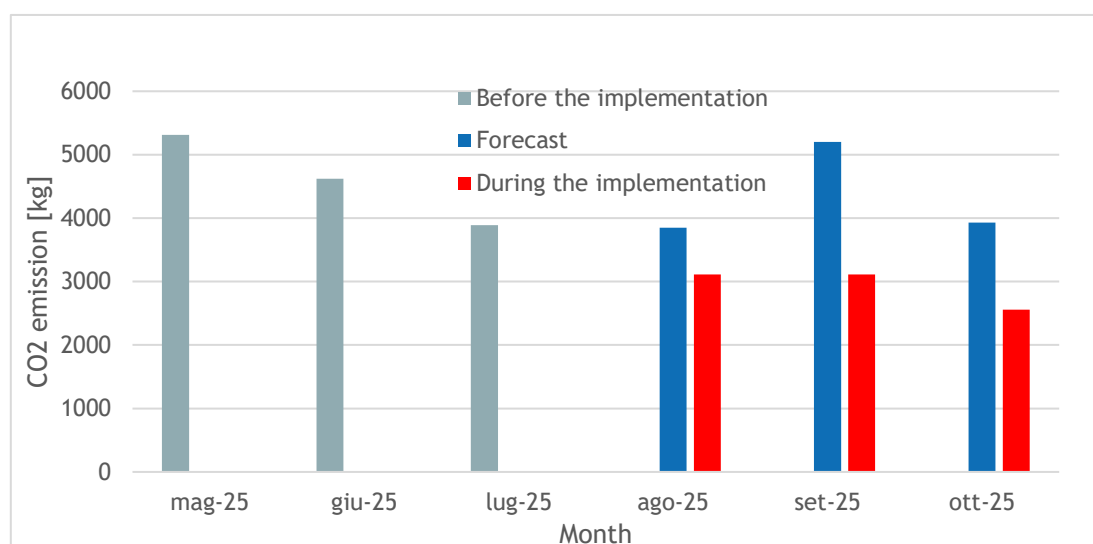


Figure 14: Normalized CO₂ emissions - railway transport

Besides greenhouse gas emissions, the Pilot Action also aimed to reduce local air pollutant emissions. The first indicator analysed is NO_x emissions. Figure 15 presents the comparison of normalized NO_x emissions.

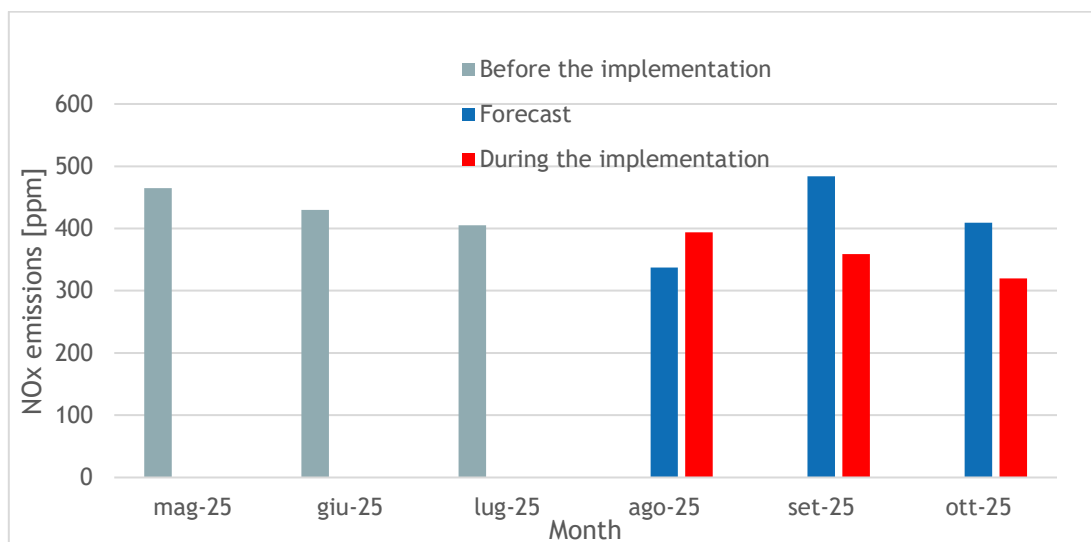


Figure 15: Normalized NOx emissions - railway transport

The measured NOx emissions were slightly above the forecast value in August, whereas clear reductions were observed in September and October. This suggests that the environmental benefits of the implemented operational measures became more evident after the initial implementation phase. Overall, the decreasing trend confirms that improved operational efficiency contributed to lower nitrogen oxide emissions.

The following figure evaluates particulate matter (PM) concentration as an additional indicator of local air quality. Figure 16 presents the comparison of normalized PM concentration before and during the EMS implementation.

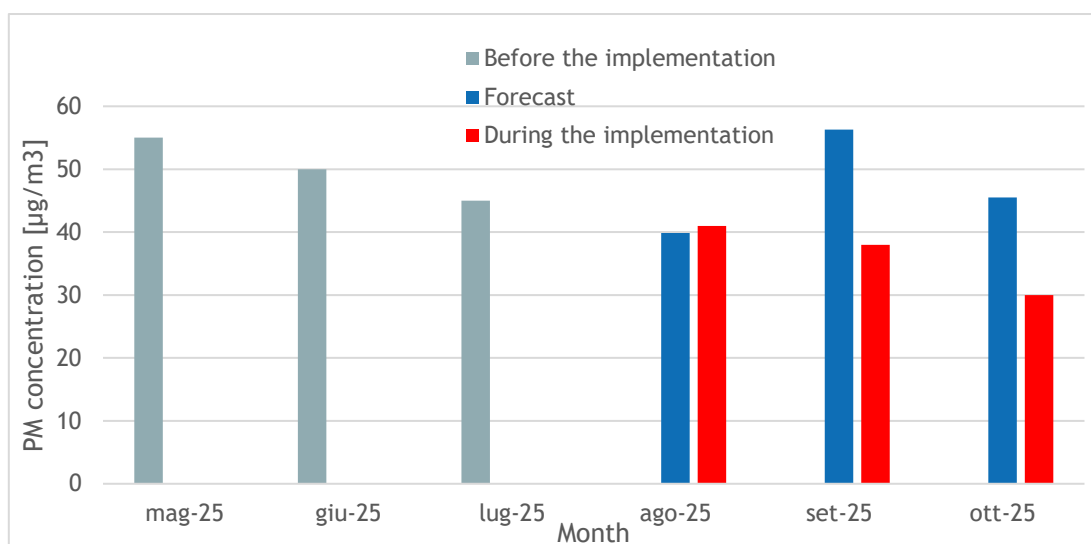


Figure 16: Normalized PM concentration - railway transport

The measured PM concentration closely matched the forecast value in August but decreased noticeably during September and October. The observed trend is consistent with the reduction in diesel consumption and indicates that the optimized operation of locomotives also contributed to lower particulate emissions within the railway yard.



Finally, the environmental assessment includes dust concentration, representing another indicator of local air quality. Figure 17 presents the comparison of normalized dust concentration before and during the EMS implementation.

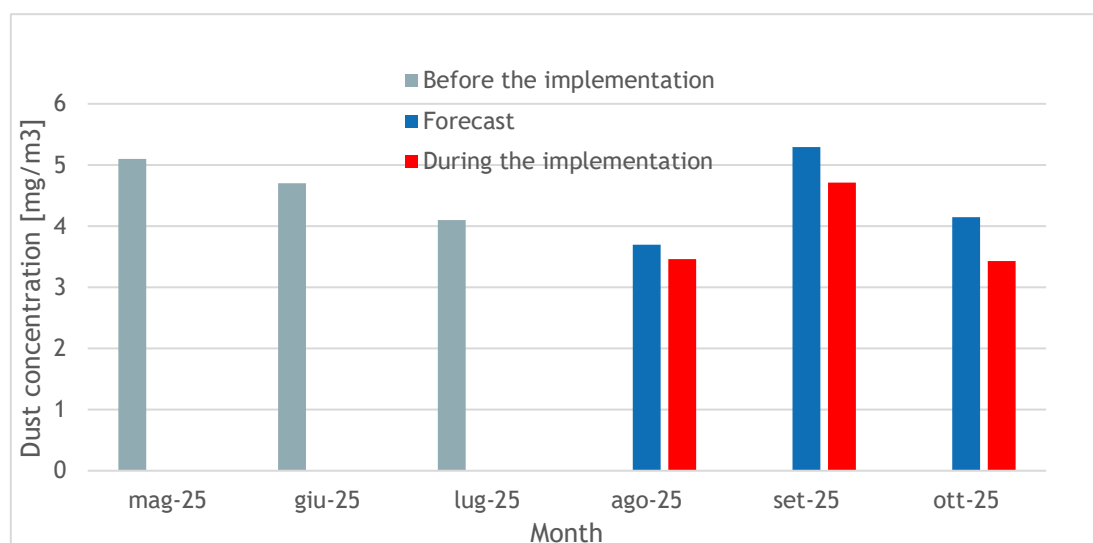


Figure 17: Normalized dust concentration - railway transport

As shown in Figure 17, the measured dust concentration remained below the forecast values throughout the implementation period. Although the differences are moderate, the consistent reduction suggests that the operational improvements introduced through the EMS contributed to limiting dust generation during railway shunting activities.

4.1.3. EMS pilot action values

Overall, the comparison against the normalized baseline demonstrates that the implemented EMS measures contributed to improved environmental performance of the railway transport pilot. The operational changes introduced during the Pilot Action reduced diesel consumption while simultaneously increasing the utilization of renewable HVO fuel. Consequently, greenhouse gas emissions, represented by CO₂ emissions, decreased throughout the implementation period, while local air quality indicators, including NO_x emissions, PM concentration and dust concentration, generally showed favourable trends. These findings demonstrate that the combination of operational optimization, systematic energy management and continuous KPI monitoring can achieve measurable environmental improvements without requiring major infrastructure investments, supporting the overall objectives of the Adriafer Pilot Action.



4.2. Air transport

4.2.1. Interpretation and analysis of KPIs

The KPI assessment provides an overview of the environmental and operational performance of the air transport pilot during the EMS implementation period. The selected indicators evaluate energy consumption, operational efficiency, indoor environmental conditions and the progress of EMS implementation. Together, these KPIs provide the basis for assessing both the environmental performance of the airport facilities and the effectiveness of the implemented EMS.

The overall KPI assessment provides an overview of the operational and environmental performance of the airport facilities during the evaluation period. As illustrated in Figure 18, approximately 3.45 million passengers were handled, while the average energy consumption amounted to 3.45 kWh per passenger. In addition, 18.94% of the total energy consumption was associated with Significant Energy Uses (SEU), indicating the proportion of energy demand originating from the airport's key operational systems. Together, these indicators establish the overall context for evaluating energy consumption and operational efficiency in the following figures.

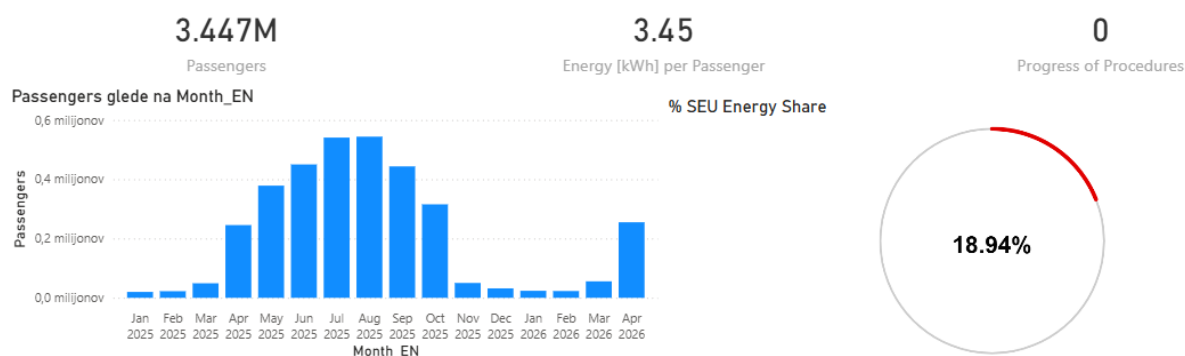


Figure 18: Overall energy performance Indicators over the monitoring period - air transport

The overall energy indicators are further supported by the monthly energy consumption trends presented in Figure 19. Total energy consumption and SEU energy consumption both increased gradually towards the summer months, reaching their highest values during July and August before declining as operational activity decreased. The similar behaviour of both indicators suggests that significant energy uses consistently follow the overall operational energy demand of the airport facilities and maintain a relatively stable share of the total energy consumption throughout the reporting period.

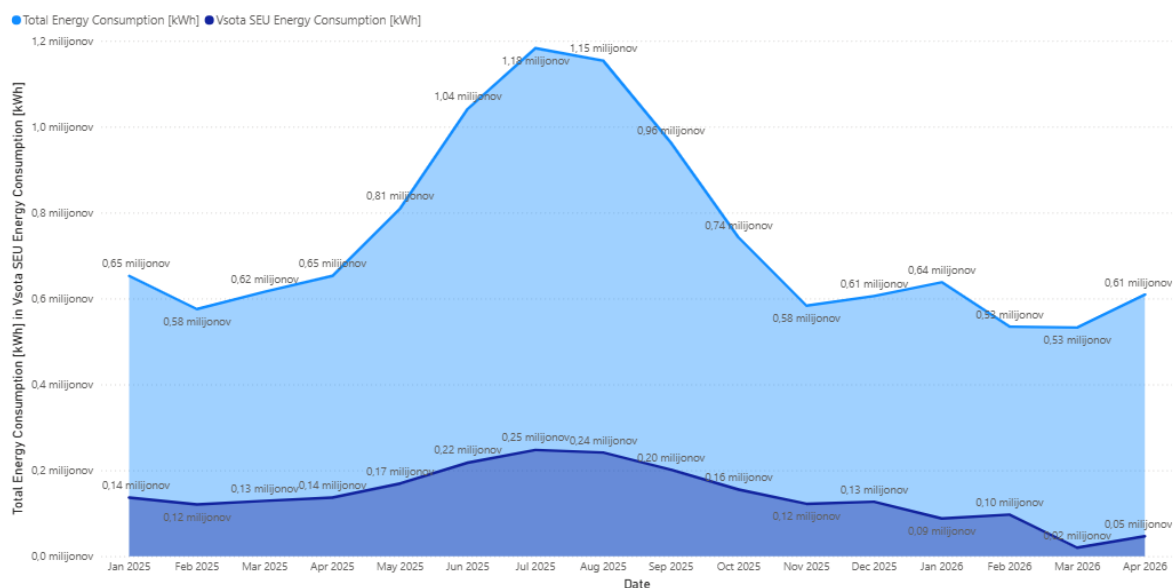


Figure 19: Total energy consumption and SEU energy consumption over the monitoring period - air transport

The seasonal variation in energy consumption closely corresponds to changes in airport utilisation. As shown in Figure 20, passenger throughput increased steadily from spring, reached its highest level during the summer season and subsequently declined towards the winter months before gradually recovering in spring 2026. This operational pattern provides important context for interpreting the energy-related KPIs, as fluctuations in building energy demand are primarily driven by passenger activity rather than changes in the efficiency of airport operations.

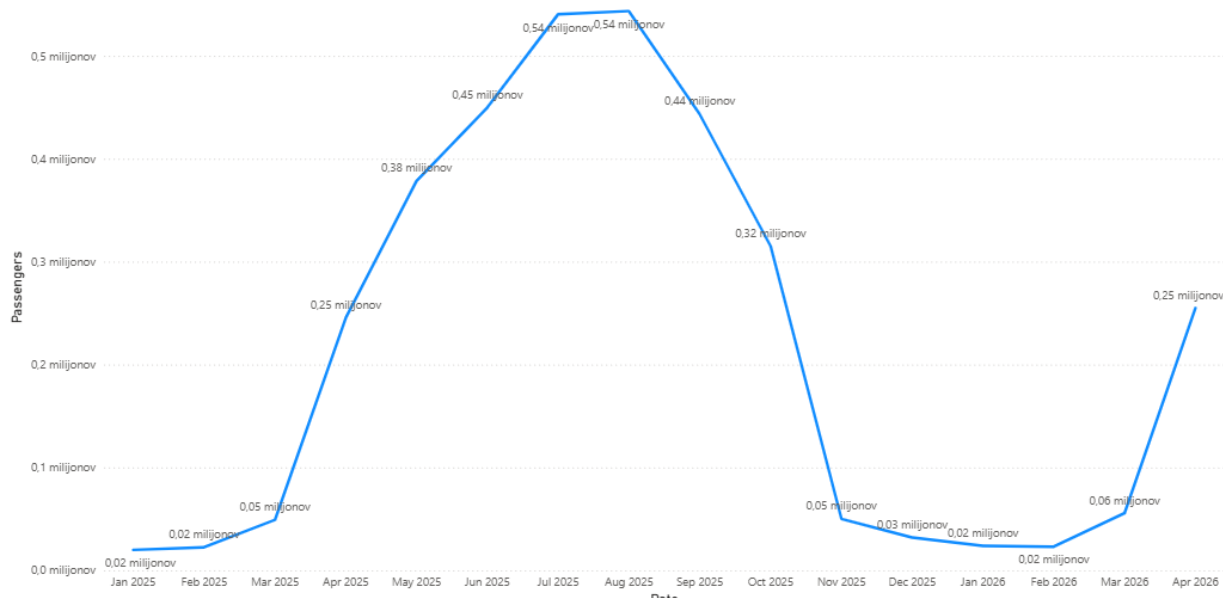


Figure 20: Passengers count over the monitoring period - air transport

While the previous figures describe the relationship between passenger throughput and total energy demand, Figure 21 provides a more representative measure of operational energy efficiency. During periods of higher passenger traffic, the specific energy consumption per passenger decreased considerably, demonstrating more efficient utilisation of the airport infrastructure. Conversely,



months with lower passenger volumes exhibited higher energy consumption per passenger due to the relatively constant base energy demand required for airport operation. The SEU energy consumption per passenger followed a comparable trend, confirming that the efficiency of significant energy uses is also closely influenced by passenger throughput.

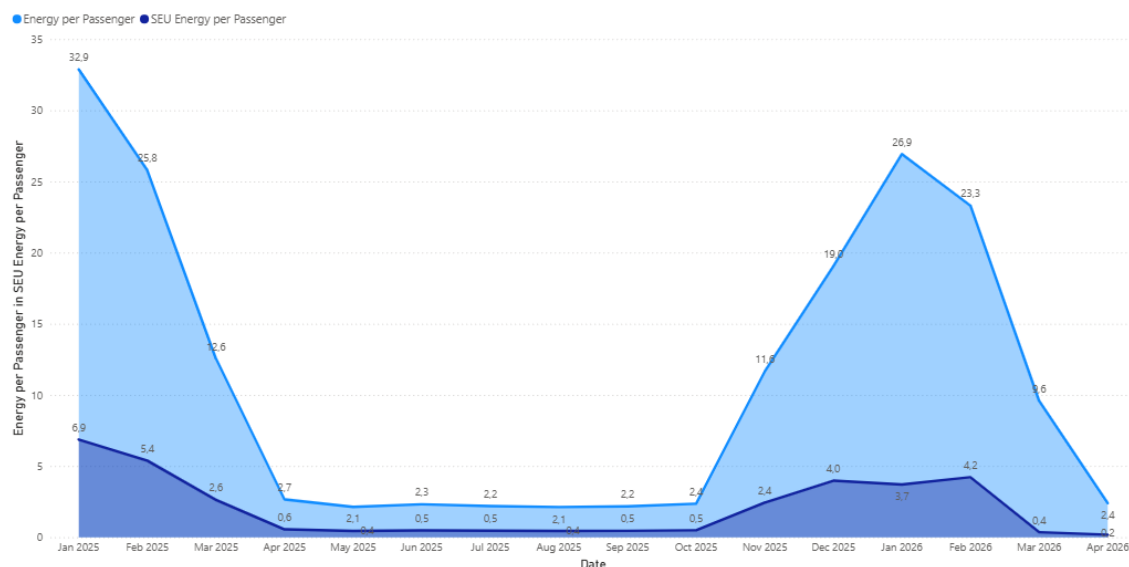


Figure 21: Energy consumption per passenger over the monitoring period - air transport

Having established the relationship between operational activity and energy performance, the monitored thermal conditions provide additional insight into building operation. As presented in Figure 22 indoor temperatures remained close to the predefined building setpoints throughout the reporting period despite considerable seasonal variations in outdoor temperature. During the summer months, outdoor temperatures exceeded the indoor setpoints, whereas lower winter temperatures required continuous heating to maintain comfortable indoor conditions. The stable indoor temperature profile demonstrates effective operation of the building management system while ensuring occupant comfort under changing climatic conditions.

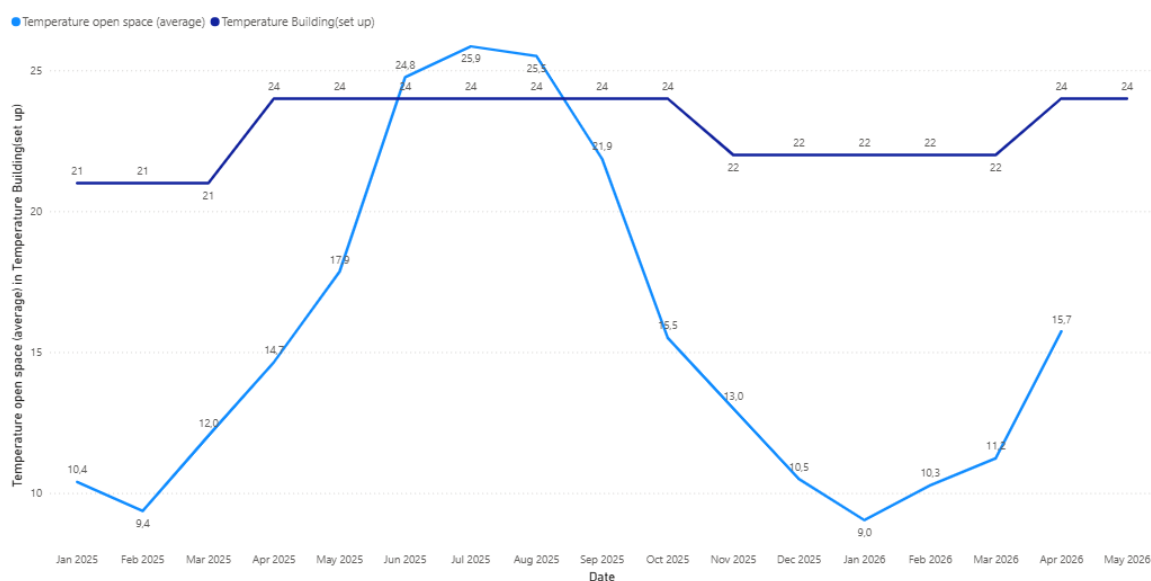


Figure 22: Building and outdoor temperature over the monitoring period - air transport



The assessment of indoor environmental conditions is complemented by the relative humidity measurements presented in Figure 23. Humidity levels exhibited typical seasonal fluctuations, with lower values during the warmer summer period and higher values during late autumn and winter. Despite these variations, humidity remained within an acceptable operational range throughout the monitoring period, indicating that the building's ventilation and climate control systems maintained stable indoor environmental conditions alongside effective temperature regulation.



Figure 23: Relative humidity over the monitoring period - air transport

The KPI assessment demonstrates that the environmental performance of the airport facilities is strongly influenced by seasonal operational demand. As passenger throughput increased during the summer period, total energy consumption also increased, while the specific energy consumption per passenger decreased, indicating improved energy efficiency under higher facility utilisation. At the same time, the monitored indoor environmental conditions remained stable despite significant seasonal variations in outdoor climate. Together, the presented KPIs provide a comprehensive overview of the airport's operational energy performance and establish a robust basis for monitoring future environmental improvements and evaluating the effectiveness of the EMS.

4.2.2. Comparison against baseline

This chapter presents a comparison of selected Key Performance Indicators (KPIs) before and during the implementation of the EMS at Dubrovnik Airport. The analysis focuses on the overall energy performance of the airport and, more specifically, on the Significant Energy User (SEU), represented by the six heat pumps included in the Pilot Action.

The selected energy consumption indicators were normalized by temperature and the number of passengers. These two parameters were selected to account for important external factors influencing airport energy consumption. Temperature directly affects the energy demand of the HVAC system, while the number of passengers represents the intensity of airport operations. The normalization therefore enables a more objective comparison between the baseline and implementation periods.



The baseline period covers January to May 2025, while the EMS implementation at Dubrovnik Airport started on 1 January 2026. Consequently, the period from January to May 2026 represents the implementation period. Since data are available for the corresponding five-month period in both years, the comparison is based on the same calendar months, thereby reducing the influence of seasonal variations.

In the following figures, “Before the implementation” represents the measured values from January to May 2025. The “Forecast” represents the expected values for January to May 2026 calculated based on the baseline and the respective normalization parameter, while “During the implementation” represents the actual measured values during the EMS implementation period. Comparing the forecast and actual values indicates whether energy performance during the implementation period improved beyond what would be expected given variations in temperature or passenger activity.

However, several technical and operational circumstances affecting the HVAC system also occurred during the implementation period. These included operational problems with two heat pumps, the replacement of one old heat pump, and an upgrade of the HVAC SCADA system. Since these changes directly influenced the operation and electricity consumption of the HVAC system, the observed changes in energy consumption cannot be attributed exclusively to the EMS implementation. These circumstances are therefore taken into account in the interpretation of the results.

4.2.2.1. Energy consumption normalized by the temperature

Since the Pilot Action in air transport primarily focuses on monitoring and improving the operation of the airport HVAC system, temperature represents one of the most relevant factors influencing energy demand. The first part of the analysis therefore evaluates total and SEU energy consumption normalized by temperature. Figure 24 presents a comparison of total airport energy consumption normalized by temperature before and during the EMS implementation.

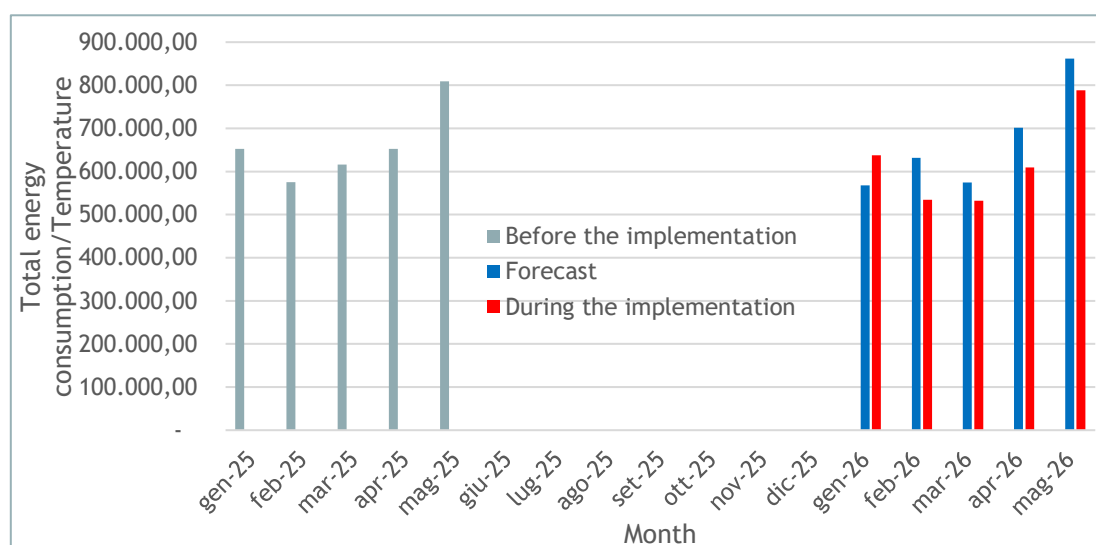


Figure 24: Total energy consumption normalized by temperature - air transport

The results show that the actual total energy consumption during the implementation period remained relatively close to the forecast values. In January, the measured consumption was slightly higher than forecast, whereas lower values were recorded from February to May. The differences were generally moderate, indicating that the overall airport energy consumption followed the expected energy demand relatively closely after accounting for temperature variations.



Nevertheless, the lower consumption observed during most of the implementation period cannot be attributed solely to the EMS. The operation of the HVAC system was affected by technical problems with two heat pumps, while one old heat pump was also replaced. These circumstances directly influenced HVAC operation and consequently contributed to changes in total airport electricity consumption. The results therefore indicate improved energy performance during most of the analysed period, although the individual contribution of the EMS cannot be fully separated from the effects of these technical and operational changes.

While the previous figure evaluates overall airport energy consumption, the Pilot Action specifically targets the six heat pumps identified as the Significant Energy User (SEU). Figure 25 therefore presents SEU energy consumption normalized by temperature and provides a more direct assessment of the equipment included within the scope of the Pilot Action.

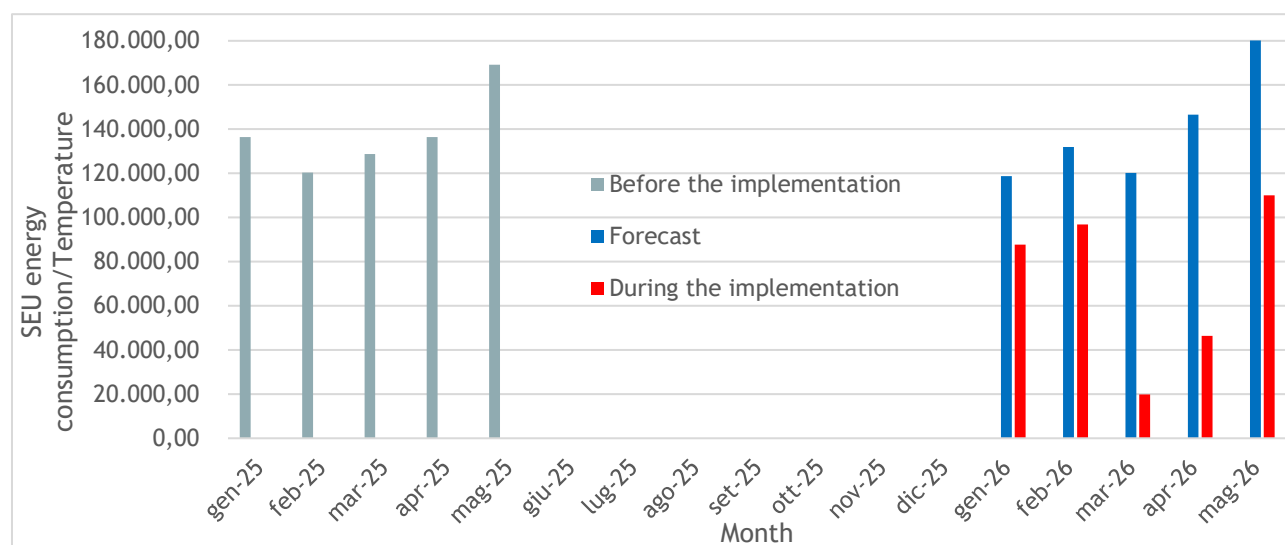


Figure 25: SEU energy consumption normalized by temperature - air transport

The measured SEU energy consumption remained below the forecast values throughout the implementation period. The differences became particularly pronounced in March and April, when the actual consumption was substantially lower than expected based on the baseline. However, these results need to be interpreted in the context of the technical condition of the HVAC system. Operational problems affecting two heat pumps and the replacement of one old heat pump directly influenced the operation and energy consumption of the SEU. Consequently, the substantial reduction in measured SEU energy consumption cannot be interpreted exclusively as an energy saving resulting from EMS optimization.

At the same time, the introduction of direct monitoring of the heat pumps, improved data collection and the HVAC SCADA upgrade are consistent with the objectives of the Pilot Action and provide an improved basis for identifying operational deviations and optimizing HVAC performance. The temperature-normalized results therefore indicate lower energy consumption during the implementation period, particularly for the SEU. However, airport energy demand is also influenced by the intensity of airport operations. For this reason, the following indicators consider the number of passengers as an additional normalization parameter.



4.2.2.2. Energy consumption normalized by passenger activity

Passenger numbers vary considerably at Dubrovnik Airport and consequently represent an important indicator of airport activity. The following analysis therefore evaluates total and SEU energy consumption relative to the number of passengers. Figure 26 presents total airport energy consumption normalized by the number of passengers.

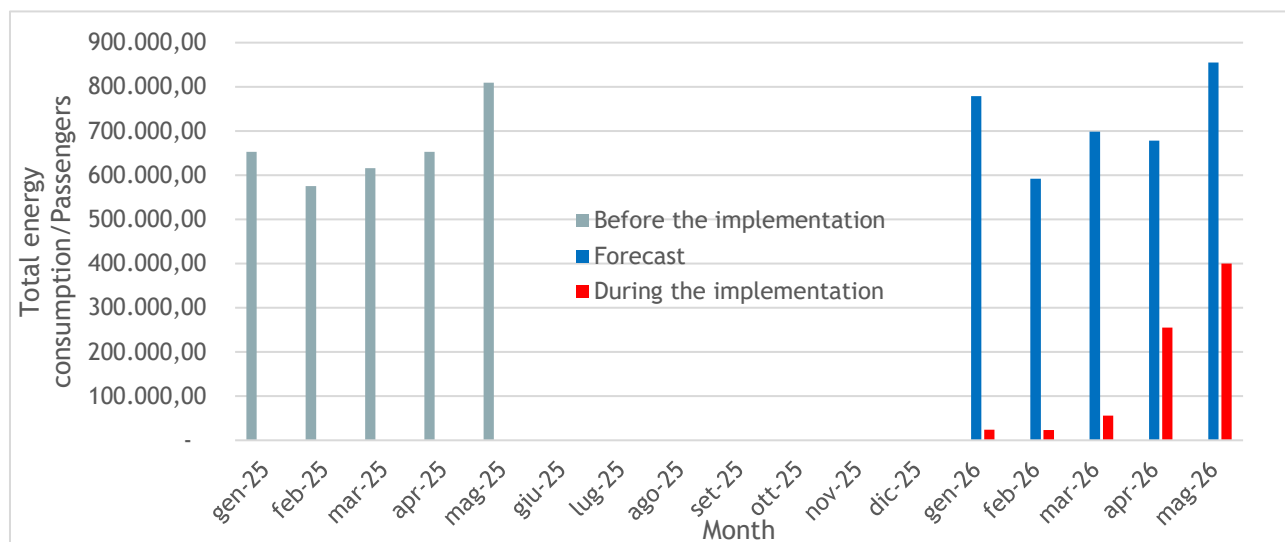


Figure 26: Total energy consumption normalized by the number of passengers - air transport

The results show that actual energy consumption remained below the forecast values throughout the implementation period. The difference between forecast and actual consumption was particularly pronounced during the first four months of 2026. In May, actual consumption increased compared with the previous months but remained considerably below the forecast value. The results indicate that the airport consumed less energy relative to passenger activity than expected based on the baseline relationship. However, as with the temperature-normalized analysis, this improvement cannot be attributed exclusively to the EMS implementation. The technical issues affecting the heat pumps and the replacement of one unit also influenced electricity demand during this period.

Therefore, the passenger-normalized results should be interpreted as an indication of improved overall energy performance during the Pilot Action period rather than as a direct measurement of energy savings achieved solely through the EMS.

To determine whether a similar trend can be observed specifically for the equipment targeted by the Pilot Action, Figure 27 presents SEU energy consumption normalized by the number of passengers.

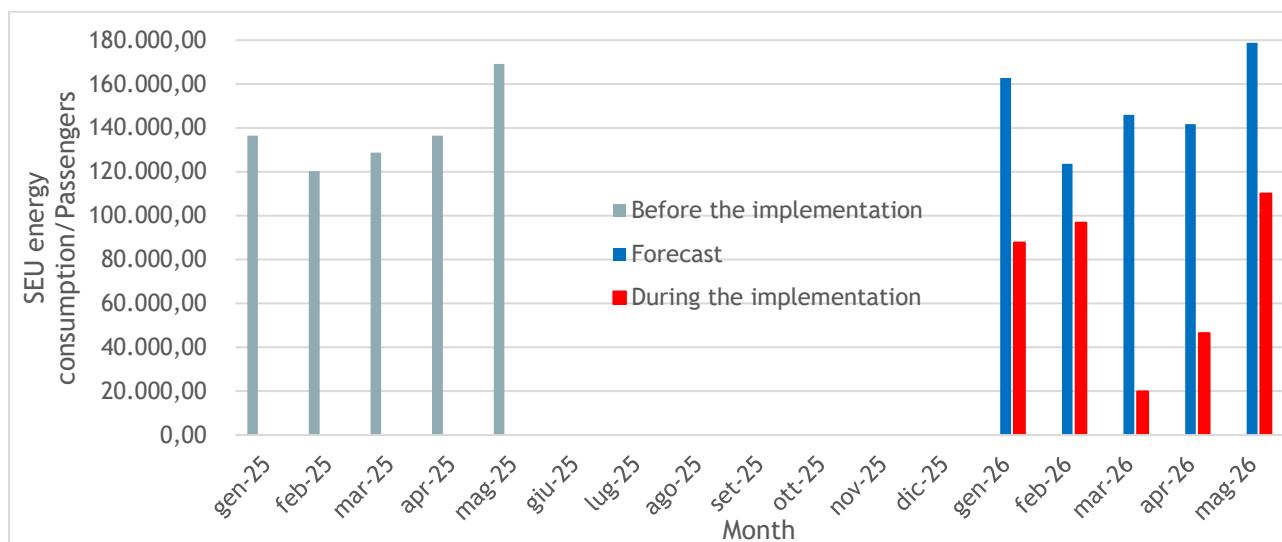


Figure 27: SEU energy consumption normalized by the number of passengers - air transport

The measured SEU energy consumption remained consistently below the forecast values throughout the analysed period. The differences were particularly pronounced in March and April, while the gap between forecast and actual consumption was smaller in February and May. Overall, the results indicate substantially lower energy consumption of the six heat pumps relative to airport activity during the EMS implementation period. Nevertheless, this indicator is particularly sensitive to the technical condition and availability of the heat pumps. Since two units experienced operational problems and one old heat pump was replaced during the analysed period, part of the reduction in SEU energy consumption is directly associated with changes in equipment operation. Consequently, the difference between forecast and actual consumption should not be interpreted solely as an energy saving resulting from the implementation of the EMS.

Together with the temperature-normalized results, however, the passenger-normalized analysis confirms that the energy performance of the SEU changed considerably during the implementation period and highlights the importance of continuous monitoring for distinguishing between energy-efficiency improvements and changes caused by equipment availability or technical interventions.

4.2.3. EMS pilot action values

Overall, the comparison against the baseline shows that both total airport energy consumption and SEU energy consumption were generally lower than forecast during the first five months of 2026. This trend is visible using both temperature- and passenger-normalized indicators, with particularly pronounced differences observed for the six heat pumps identified as the Significant Energy User.

The two normalization approaches provide complementary perspectives on energy performance. Temperature normalization accounts for variations in HVAC demand associated with weather conditions, while passenger normalization relates energy consumption to the intensity of airport operations. The fact that actual values generally remained below the forecast under both normalization approaches indicates improved energy performance during the implementation period.

However, an important limitation must be considered when evaluating the impact of the Pilot Action. During the analysed period, two heat pumps experienced operational problems, one old heat pump was replaced, and the HVAC SCADA system was upgraded. These events affected the operation and electricity consumption of the HVAC system and therefore influenced the measured KPI values. Consequently, the observed reductions represent the combined effect of EMS implementation,



technical interventions, equipment availability and changes in HVAC operation, rather than an isolated effect of the EMS.

Nevertheless, the results remain relevant to the objectives of the Dubrovnik Airport Pilot Action. One of its principal aims was not only to reduce energy consumption, but also to establish a more comprehensive monitoring and reporting framework for the HVAC system. The introduction of direct monitoring of individual heat pumps, improved data collection, SCADA-based monitoring and integration of operational data into the customized EMS provides Dubrovnik Airport with an improved basis for identifying deviations, evaluating energy performance and supporting data-driven operational decisions.

Therefore, the contribution of the Pilot Action should not be evaluated solely through the absolute reduction in electricity consumption. The establishment of a more robust monitoring and decision-support framework represents an important outcome and provides the basis for continuous optimization of HVAC operation and long-term improvement of energy performance at Dubrovnik Airport.



4.3. Urban transport

4.3.1. Interpretation and analysis of KPIs

The KPI assessment provides an overview of the operational and environmental performance of the urban transport facilities during the monitoring period. The selected indicators evaluate resource consumption, operational activity, environmental quality and energy performance, providing a comprehensive basis for assessing the efficiency of facility operation and establishing the reference framework for future EMS implementation.

The overall KPI assessment provides an initial overview of the environmental performance of the monitored urban transport facilities. As illustrated in Figure 28, the average energy consumption amounted to 1.511 kWh per square meter of building area, while the average NO₂ concentration remained at 24 µg/m³ throughout the monitoring period. These indicators establish the overall context for evaluating resource consumption, operational activity and local environmental conditions presented in the following figures.



Figure 28: Overall performance indicators over the monitoring period - urban transport

The overall performance indicators are further supported by the relationship between building energy consumption and operational activity as shown in Figure 29 (Energy Consumption per Building Area and Tickets per Travel Hours). Energy consumption varied throughout the reporting period, with higher values recorded during the winter months and lower values observed during periods of reduced heating demand. In contrast, the operational indicator remained relatively stable, indicating that fluctuations in energy consumption were primarily associated with seasonal building operation rather than changes in transport service utilisation.

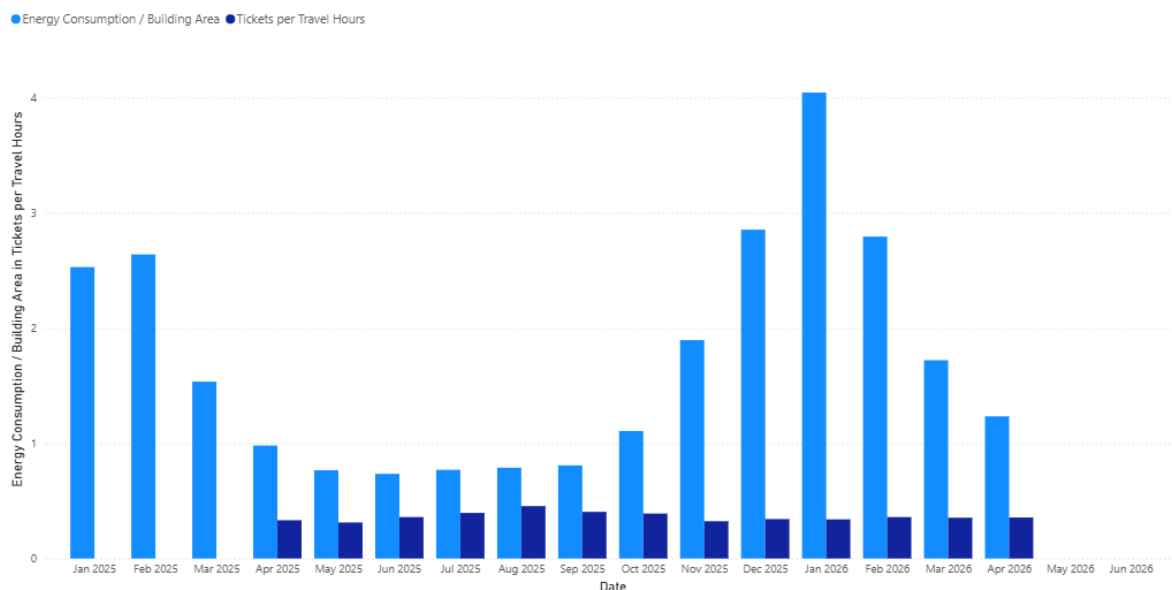


Figure 29: Energy consumption per building area and tickets per travel over the monitoring period - urban transport

The relationship between transport activity and passenger demand is illustrated in Figure 30. The positive correlation between travel hours and ticket sales indicates that higher operational activity generally corresponds to increased passenger utilisation. Although some variability is present, the observed relationship demonstrates that transport demand remains closely linked to service availability, providing an important operational context for interpreting the resource consumption indicators discussed throughout this assessment.

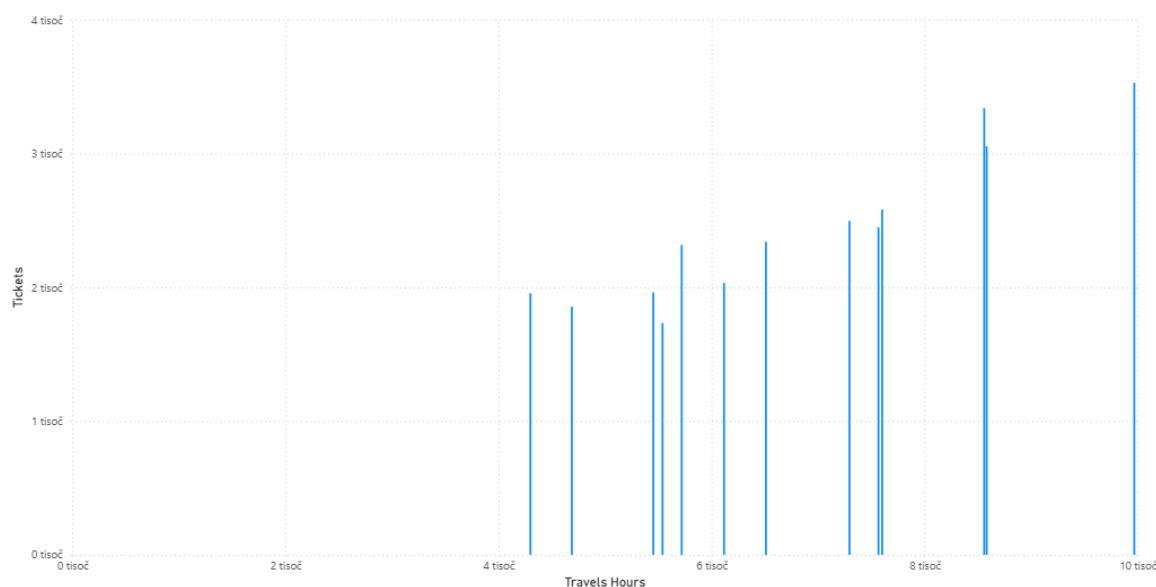


Figure 30: Tickets versus travel hours over the monitoring period - urban transport

The environmental impact of urban transport operations is further evaluated through the monitored NO₂ concentrations presented in Figure 31 and 32. Concentrations remained relatively stable throughout most of the monitoring period, then increased briefly in late 2025 and subsequently declined to substantially lower levels by the end of the evaluation period. The accompanying



relationship between NO₂ concentration and travel hours indicates that local air quality is not solely dependent on operational activity, suggesting that additional external factors, including meteorological conditions and surrounding traffic, may also influence measured concentrations.

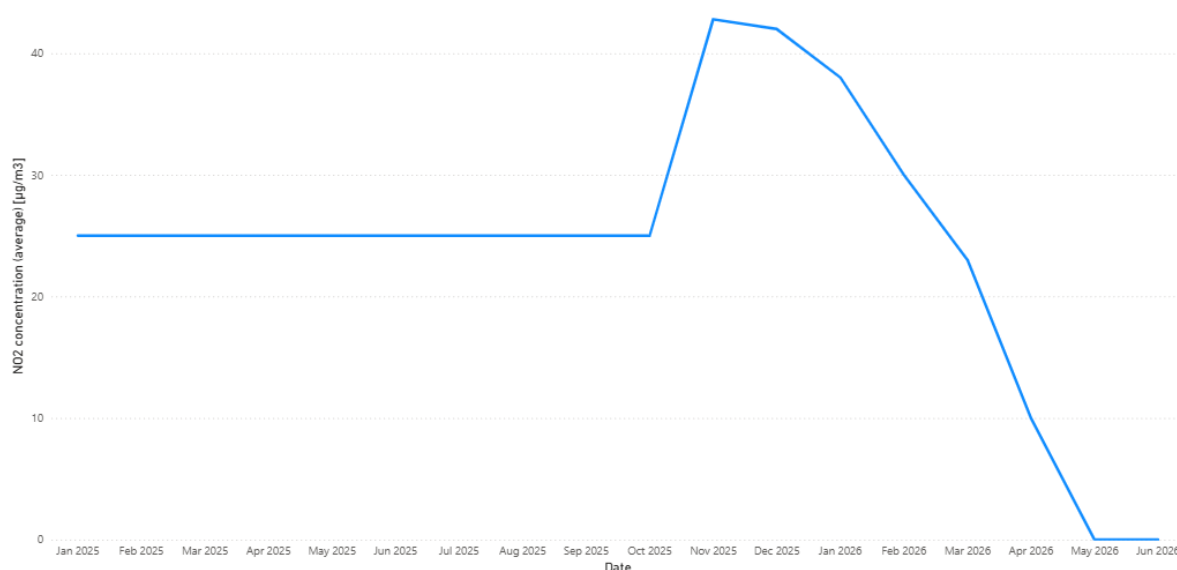


Figure 31: Average NO₂ concentration over the monitoring period - urban transport

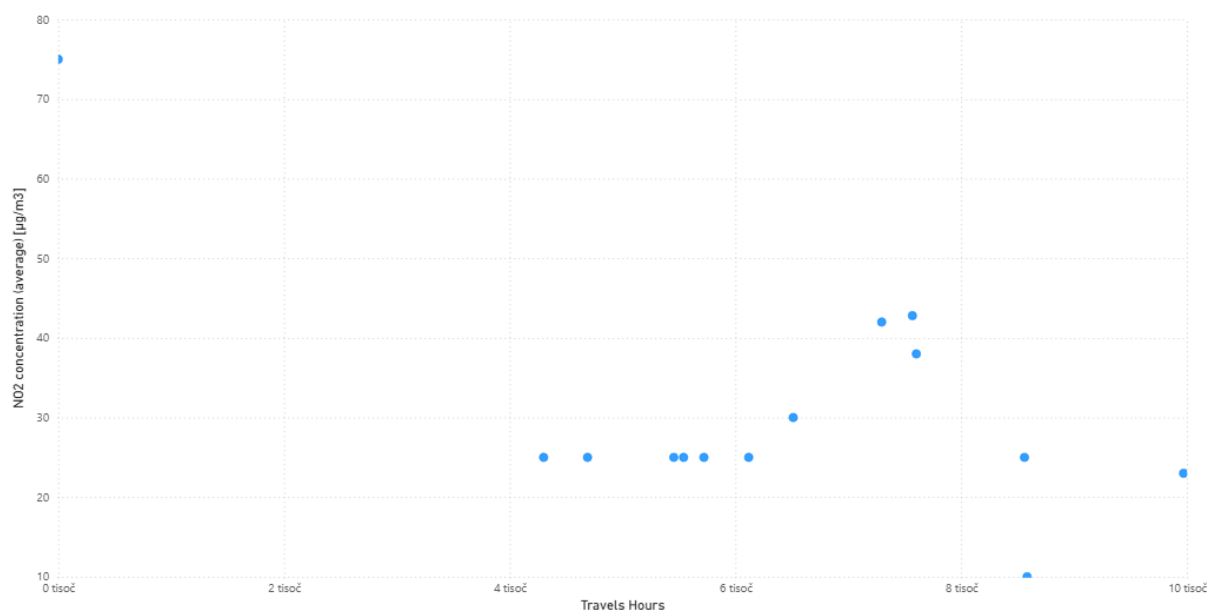


Figure 32: NO₂ concentration based on travel hours over the monitoring period - urban transport

Overall, the KPI assessment indicates that the operational performance of the monitored urban transport facilities remained stable throughout the reporting period, while resource consumption was primarily influenced by seasonal building operations rather than changes in transport activity. The relationship between ticket sales and travel hours confirms consistent service utilisation, whereas variations in energy and water consumption reflect the operational requirements of facility management. Environmental monitoring showed generally acceptable NO₂ concentrations, although temporary increases emphasise the importance of continued air quality monitoring. Finally, the absence of renewable energy utilisation identifies a significant opportunity for future environmental



improvement and represents one of the principal areas where further EMS implementation measures could enhance the sustainability performance of the urban transport facilities.

4.3.2. Comparison against baseline

This chapter presents a comparison of selected Key Performance Indicators (KPIs) before and during the implementation of the Environmental Management System (EMS) at the Górka Narodowa Park & Ride (P+R) facility and its bus terminal in Kraków. The Pilot Action focuses on improving the understanding and management of energy consumption through real-time monitoring, energy performance analysis, anomaly detection and the integration of operational EMS data with building simulation tools.

The main energy-related KPI analysed within the comparison is electricity consumption. However, absolute electricity consumption alone does not provide a sufficiently representative indication of energy performance, as the energy demand of the facility is also influenced by the intensity of its use. For this reason, electricity consumption was additionally evaluated in relation to two operational parameters: the number of tickets and travel hours. These parameters indicate the level of transport activity and therefore allow changes in electricity consumption to be evaluated independently of variations in facility usage.

Due to the availability of operational data, the baseline calculation is based on the available corresponding data from 2025. The EMS implementation at the Górka Narodowa facility started in April 2026. The comparison therefore distinguishes between the period before implementation and the values observed after the EMS was introduced. Where normalization is applied, the “Forecast” represents the expected electricity consumption based on the baseline relationship between energy consumption and the respective operational parameter, while “During the implementation” represents the actual measured electricity consumption.

This approach is particularly important for the GMK Pilot Action because an increase in absolute electricity consumption does not necessarily indicate a deterioration in energy performance. If the facility handles a higher level of transport activity, an increase in electricity demand may be expected. The normalized comparison therefore provides a more appropriate basis for assessing whether the facility operated more efficiently during the EMS implementation period.

The first normalized indicator evaluates electricity consumption in relation to travel hours, representing the operational intensity of transport services associated with the facility. Figure 33 presents the baseline electricity consumption, the forecast consumption based on travel hours, and the actual measured consumption during the analysed period.

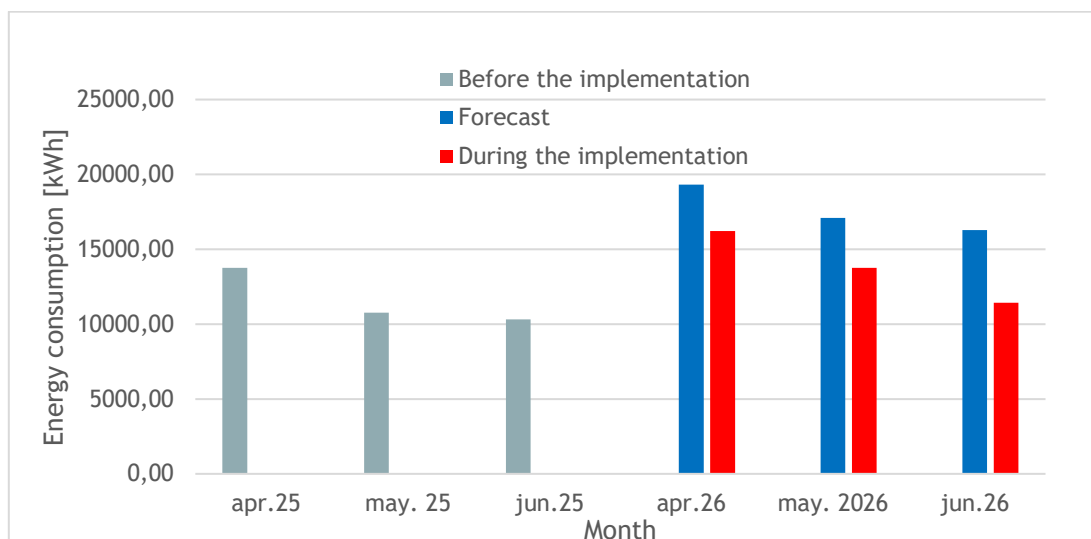


Figure 33: Energy consumption normalized by travel hours - urban transport

The comparison shows that the actual electricity consumption remained below the forecast throughout the analysed period. In March, approximately 16,200 kWh was consumed compared with an expected 19,300 kWh. The difference continued in April, with around 13,750 kWh measured against a forecast of 17,100 kWh, and became even more pronounced in May, when consumption decreased to approximately 11,400 kWh compared with the expected 16,300 kWh.

This consistently favourable difference indicates that the facility required less electricity than expected considering the level of transport activity represented by travel hours. The improvement is particularly relevant in April and May 2026, following the start of EMS implementation, with the gap between expected and measured consumption becoming most pronounced in May. This trend is in line with the Pilot Action's focus on continuous energy monitoring, identification of operational inefficiencies and optimization of the facility's energy performance. Nevertheless, given the relatively short evaluation period, the observed development should be considered an indication of improved performance rather than attributed exclusively to the EMS.

To complement this operational perspective, energy performance was also assessed in relation to the number of tickets, which reflects the intensity of facility use from a different perspective. Figure 34 presents this comparison and provides an additional basis for evaluating whether changes in electricity demand corresponded to changes in transport activity.

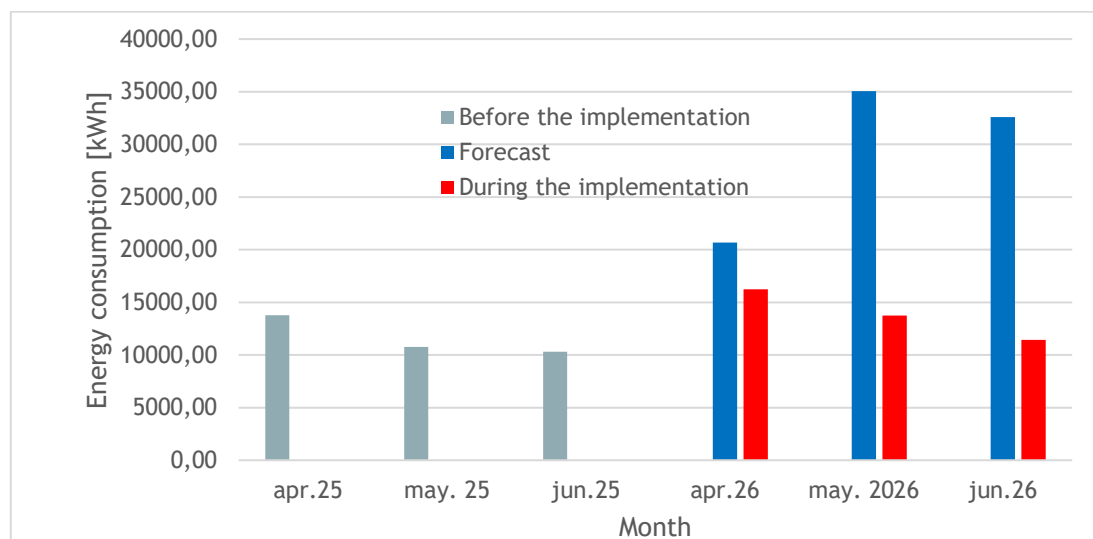


Figure 34: Energy consumption normalized by the number of tickets - urban transport

A more pronounced difference between forecast and measured consumption can be observed when the number of tickets is used as the normalization parameter. In March 2026, approximately 16,200 kWh was consumed compared with a forecast of 20,700 kWh. The gap widened considerably in April, when actual consumption amounted to around 13,750 kWh against an expected 35,000 kWh, and remained substantial in May, with approximately 11,400 kWh measured compared with a forecast of 32,600 kWh.

The increasing difference in April and May is primarily associated with the considerably higher number of tickets compared with the baseline period. Based on the relationship established for 2025, this higher level of activity would normally have been accompanied by a substantial increase in electricity demand. Instead, the measured consumption remained well below the expected values, indicating that the facility accommodated increased activity without a proportional rise in energy use. This points to a favourable development in energy performance and is consistent with the Pilot Action's broader objective of improving the monitoring and optimization of energy flows within the P+R facility.

While both normalized indicators point towards improved energy performance relative to operational activity, it is also important to consider how the absolute electricity demand changed between the two years. This provides additional context for the normalized results and illustrates why operational activity needs to be considered when evaluating the impact of the Pilot Action. Figure 35 therefore presents the percentage change in electricity consumption between the corresponding months of 2025 and 2026.

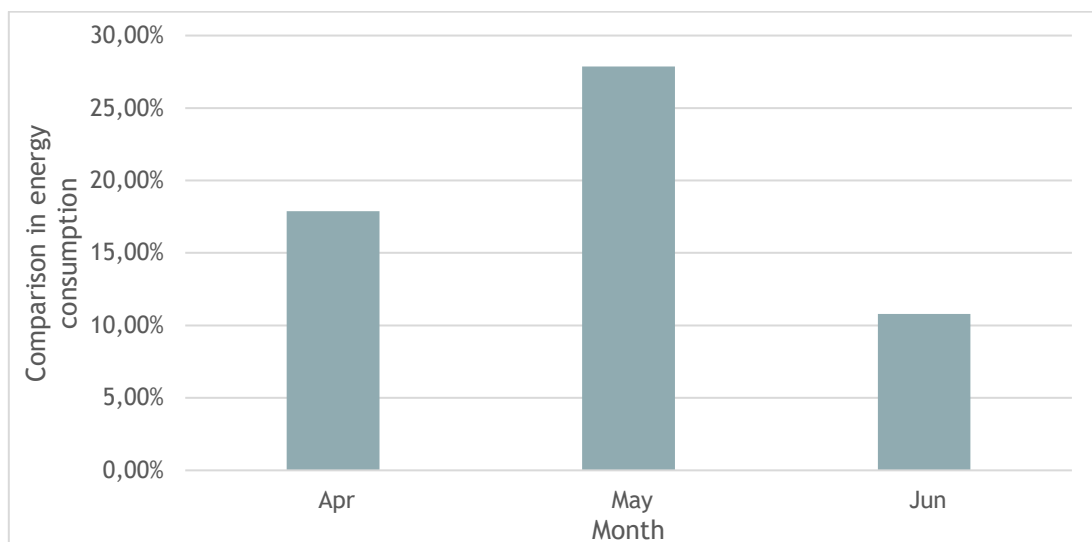


Figure 35: Monthly comparison in energy consumption between the year 2025 and 2026 - urban transport

In contrast to the normalized indicators, the comparison of absolute values shows an increase in electricity consumption in all three corresponding months, amounting to approximately 17.9% in April, 27.9% in May and 10.8% in June. Although these figures could initially suggest a deterioration in energy performance, they need to be considered in relation to the operational activity of the facility.

The number of tickets and travel hours varied considerably between the analysed periods, meaning that higher electricity demand was also associated with changes in the intensity of facility use. This is particularly relevant for urban transport infrastructure, where improved energy efficiency should not result from reduced transport activity, but rather from providing the required level of service with a more efficient use of energy.

The increase in absolute consumption should therefore be considered together with the previously presented normalized indicators. While the facility consumed more electricity in absolute terms, the analysis based on travel hours and tickets indicates that energy demand was lower than expected relative to the level of operational activity. This demonstrates the importance of normalization when assessing the energy performance of the GMK Pilot Action and provides a more representative basis for evaluating the developments observed during the EMS implementation period.

4.3.3. EMS Pilot Action values

Overall, the comparison against the baseline indicates a favourable development in the energy performance of the Górka Narodowa P+R facility during the analysed EMS implementation period. Although absolute electricity consumption increased compared with the corresponding months of 2025, the operational data show that the level of activity also changed considerably. Therefore, absolute electricity consumption alone does not adequately describe the energy performance of the facility.

Normalization by travel hours shows that actual electricity consumption remained below the forecast values throughout the analysed period, with increasingly favourable differences towards May. The normalization by number of tickets indicates an even stronger improvement, particularly in April and May, when the facility recorded substantially higher activity while electricity consumption remained considerably below the level that would have been expected based on the baseline relationship.



These findings indicate that the facility was able to accommodate increased operational activity without a proportional increase in electricity consumption. This represents an important result from an energy-efficiency perspective and is consistent with the objectives of the GMK Pilot Action.

At the same time, the results should be interpreted with appropriate caution. The analysed EMS implementation period is relatively short, and the Pilot Action itself places considerable emphasis on establishing monitoring capabilities, identifying anomalies, developing energy performance indicators and integrating real operational data with digital building modelling. Consequently, the value of the Pilot Action should not be assessed solely through short-term reductions in electricity consumption.

The implementation of the EMS provides GMK with a systematic basis for continuous monitoring of the facility, identification of inefficient operating conditions and evaluation of potential optimization measures. Combined with the DesignBuilder model and the Smart Readiness Indicator assessment, the collected operational data can support the evaluation of future measures such as improved building automation, photovoltaic systems, battery storage, heat pumps, thermal storage and intelligent lighting and climate control.

Overall, the results demonstrate the importance of evaluating energy consumption in relation to the level of transport activity. The GMK Pilot Action indicates that the combination of real-time monitoring, normalized energy performance indicators and building simulation can provide a more reliable basis for identifying energy-saving opportunities and supporting the continuous improvement of energy performance in urban transport infrastructure.



4.4. Waterway transport

4.4.1. Interpretation and analysis of KPIs

The KPI assessment provides an overview of the operational and environmental performance of the waterway transport facilities during the monitoring period. The selected indicators evaluate electricity and fuel consumption, thermal performance of the buildings, heating demand and the influence of outdoor climatic conditions on overall energy use. Together, these KPIs provide a comprehensive assessment of resource utilisation and establish the basis for evaluating future EMS improvements.

The KPI assessment begins with the overall electricity performance of the monitored facilities. As illustrated in Figure 36, electricity consumption remained relatively stable throughout most of the reporting period, fluctuating between approximately 3.3 and 4.5 kWh/m². A moderate increase was observed during the winter months, reflecting higher operational energy demand, before decreasing again towards spring. This indicator provides the overall reference for evaluating the contributions of individual electricity consumers, as presented in the following figures.

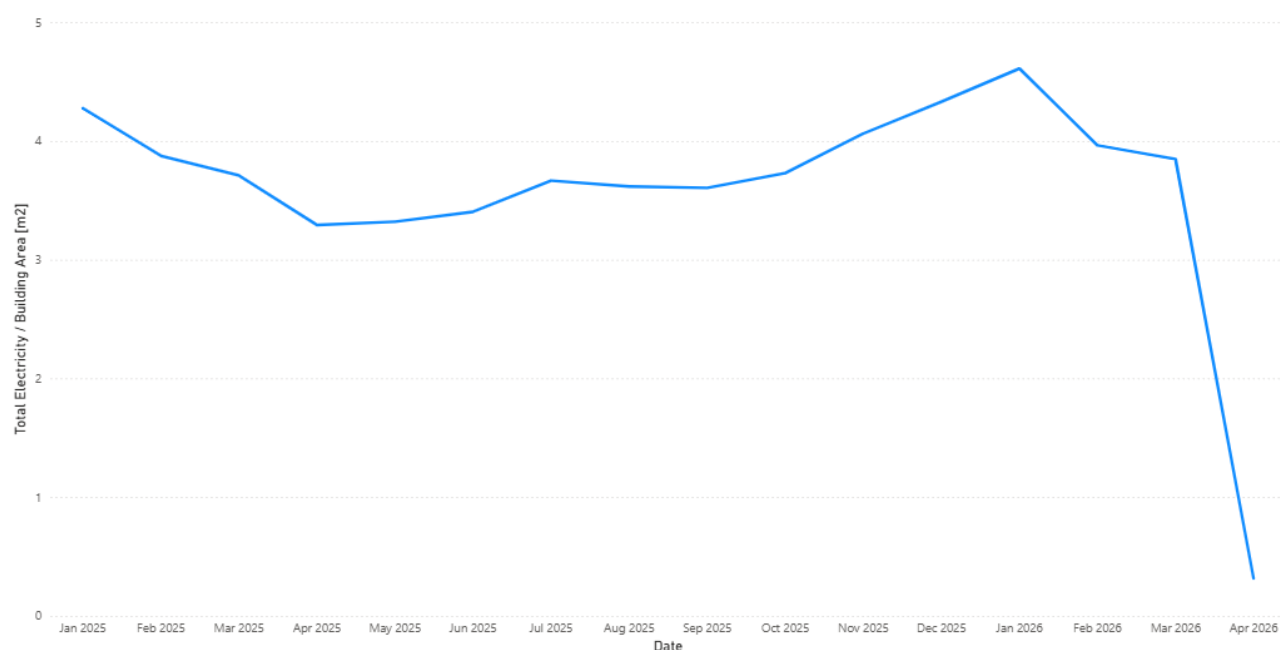


Figure 36: Total electricity consumption per building area over the monitoring period - waterway transport

The overall electricity demand is further explained through the distribution of individual electricity consumers presented in Figures 37 and 38. The majority of electricity consumption originated from the 12 electricity supply points (PODs), representing approximately 89% of the total monitored electricity use, while outdoor lighting accounted for the remaining 11%. Both indicators exhibited relatively stable seasonal behaviour, with slightly increased electricity demand during the winter period. The results indicate that general building operation remains the dominant contributor to electricity consumption within the monitored facilities.

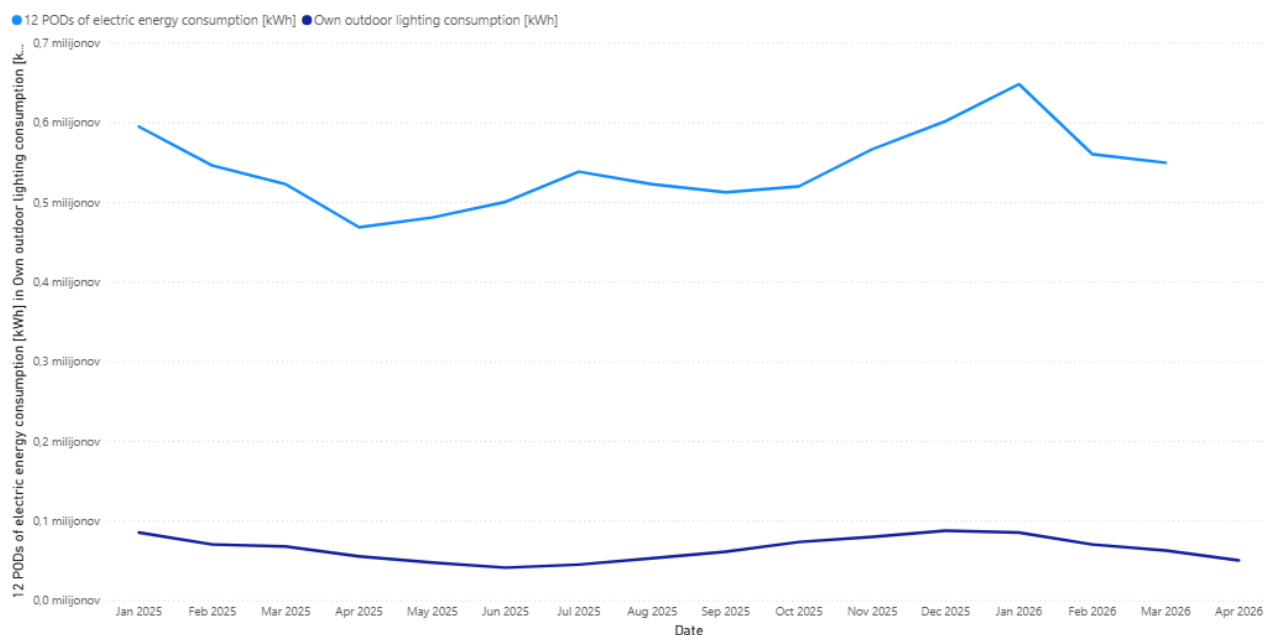


Figure 37: Electric energy consumption and own outdoor lighting over the monitoring period - waterway transport

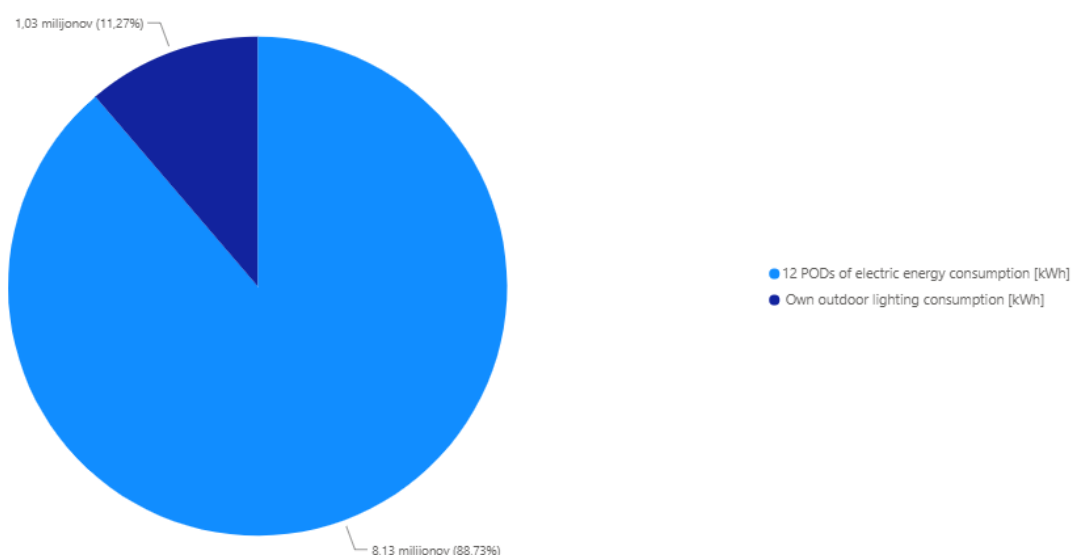


Figure 38: Electric energy consumption and own outdoor lighting consumption (pie chart) over the monitoring period - waterway transport

In addition to electricity consumption, the monitored facilities utilise several conventional energy carriers for operational activities. As shown in Figure 39, natural gas represented the largest share of total fuel consumption, accounting for approximately 54%, while diesel and gasoline contributed nearly equal shares of around 23% each. The diesel share indicator further confirms that diesel accounted for approximately 50% of total liquid fuel consumption, providing an overview of the relative contribution of transport fuels to the overall energy mix. These results demonstrate that thermal energy demand remains the dominant component of fossil fuel consumption within the monitored facilities.

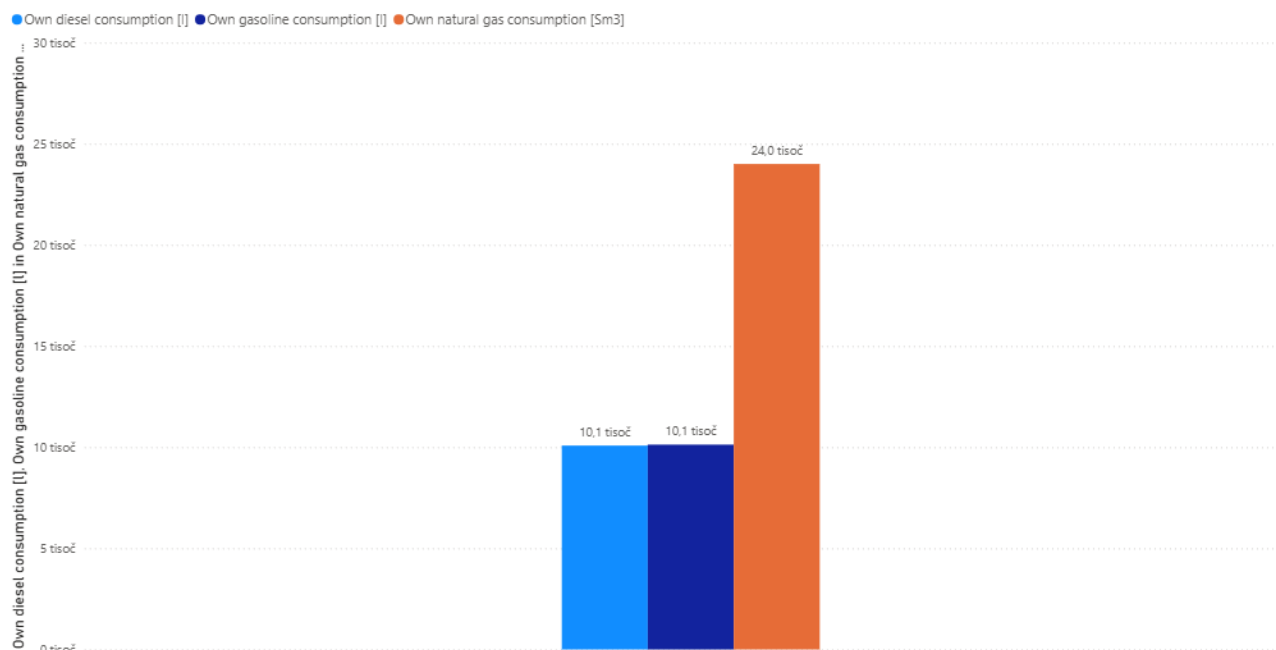


Figure 39: Fuel consumption structure during over the monitoring period - waterway transport

The seasonal variation in fuel consumption is closely related to changing climatic conditions. As presented in Figure 40 and Figure 41, heating demand increased significantly during colder periods, as reflected by higher Heating Degree Day (HDD) values, while outdoor temperatures followed the expected seasonal cycle. Conversely, the summer months were characterised by minimal heating demand due to higher ambient temperatures. These climatic indicators provide the environmental context required for interpreting the building's thermal performance, presented in the following figure.

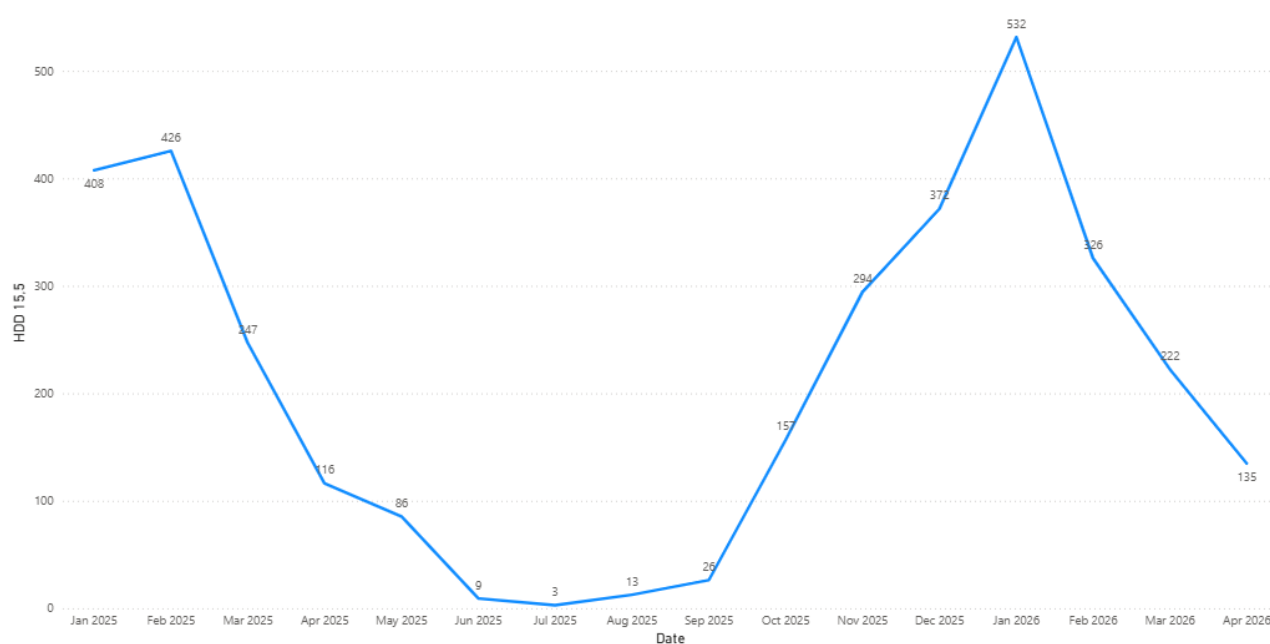


Figure 40: Heating degree days (HDD) over the monitoring period - waterway transport

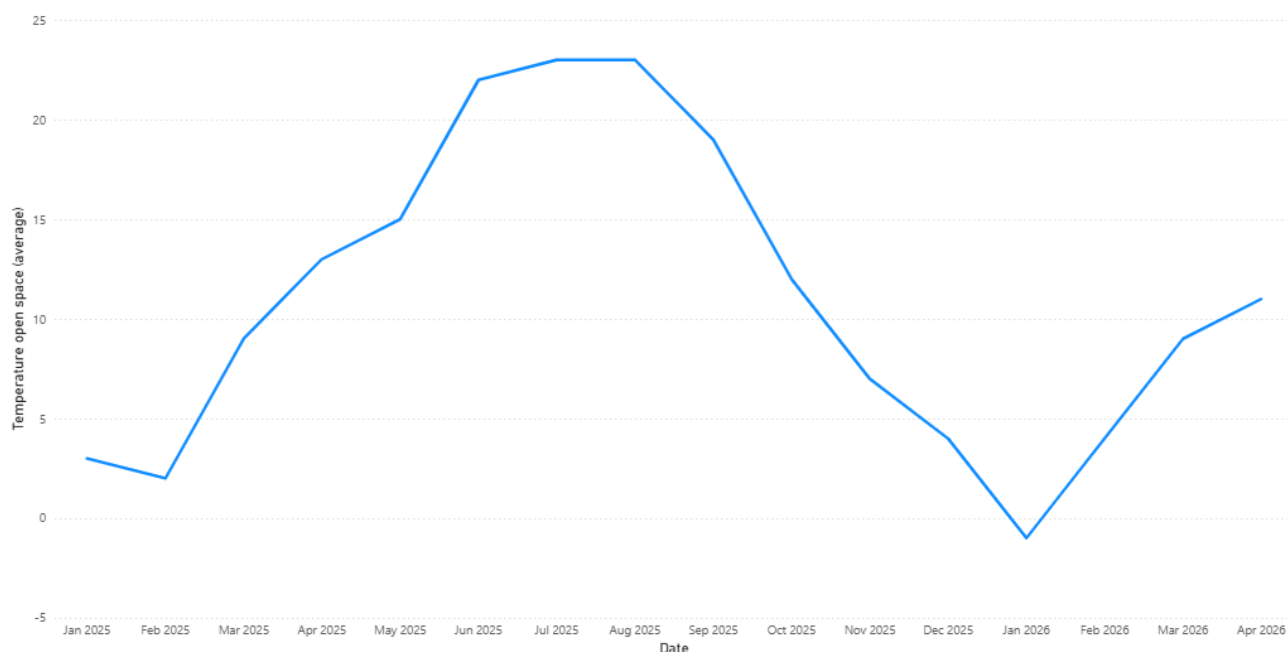


Figure 41: Temperature open space over the monitoring period - waterway transport

Overall, the KPI assessment demonstrates that the environmental performance of the monitored waterway transport facilities is primarily influenced by seasonal building operation and heating demand. Electricity consumption remained relatively stable throughout the reporting period, while natural gas represented the dominant fuel source supporting thermal energy requirements. The relationship between heating demand, outdoor temperature and natural gas consumption confirms that the building energy systems respond consistently to changing climatic conditions. Furthermore, the electricity consumption structure highlights that the majority of electrical energy is associated with general facility operation, whereas outdoor lighting represents a comparatively small share of total electricity demand. Together, these KPIs establish a comprehensive baseline for evaluating future EMS implementation measures and monitoring long-term improvements in energy efficiency.

4.4.2. Comparison against baseline

This chapter presents a comparison of selected Key Performance Indicators (KPIs) before and during the implementation of the Environmental Management System (EMS) at the Freeport of Budapest. The analysis focuses on the energy consumption directly influenced by FBL, in accordance with the scope of the Pilot Action. Since more than 90% of the total energy consumption at the port is attributable to tenants, the evaluation focuses exclusively on those energy uses that can be directly managed and influenced by FBL.

The baseline period covers January to May 2025, while the implementation of the EMS started in January 2026. Consequently, the period from January to May 2026 represents the implementation period. The availability of data for the corresponding five months in both years enables a direct comparison while limiting the influence of seasonal differences.

For energy consumption related to heating, the selected KPIs were normalized using Heating Degree Days (HDD). The HDD indicator reflects the difference between the reference temperature of 15.5 °C and the outdoor temperature and therefore accounts for differences in heating demand caused by weather conditions. This normalization enables a more objective comparison of heating-related energy performance between the two periods.



In the following figures, “Before the implementation” represents the measured values from January to May 2025. The “Forecast” represents the expected consumption for January to May 2026 based on the baseline and the corresponding HDD conditions, while “During the implementation” represents the actual measured consumption during the EMS implementation period.

For outdoor lighting and fleet fuel consumption, HDD normalization was not applied, as these energy uses are not directly dependent on heating demand. These indicators were therefore evaluated through a direct comparison between the corresponding months of 2025 and 2026.

4.4.2.1. Heating related energy consumption

One of the main objectives of the FBL Pilot Action was to reduce energy consumption associated with heating systems by 8%. The first part of the analysis therefore focuses on natural gas and electrical energy consumption associated with the relevant Points of Delivery (PODs), normalized by HDD. Figure 42 presents the comparison of FBL's own natural gas consumption normalized by HDD.

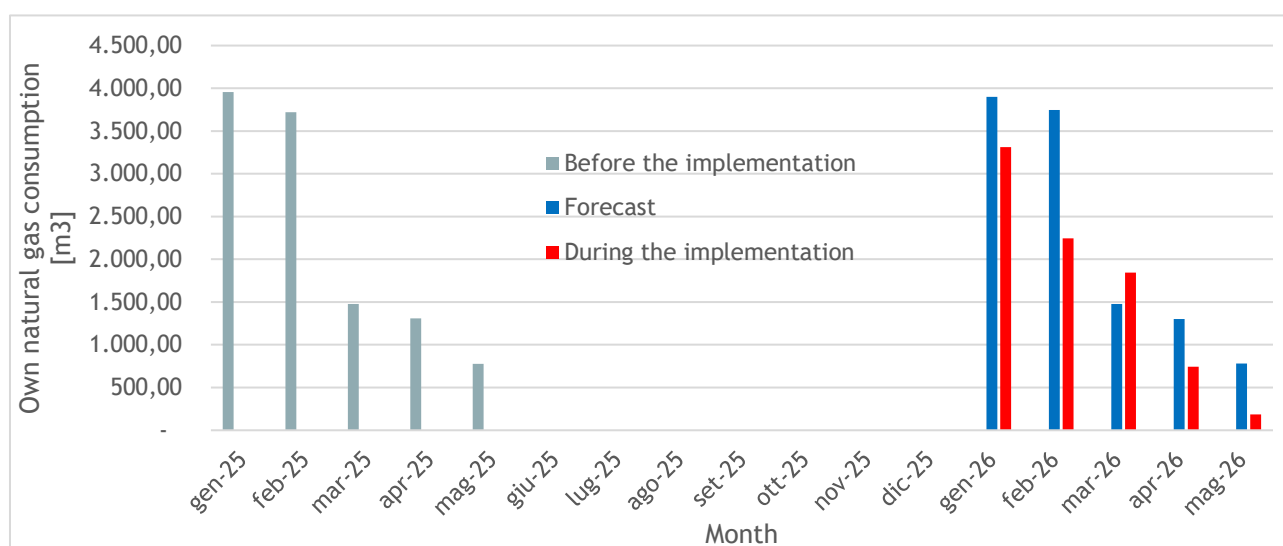


Figure 42: Natural gas consumption normalized by HDD - waterway transport

The results show that actual natural gas consumption was generally lower than the forecast during the EMS implementation period. Lower values were recorded in January, February, April and May, while March represents an exception, with consumption exceeding the forecast value. Since the indicator is normalized by HDD, the observed differences are not primarily attributable to variations in outdoor temperature and therefore provide a more representative indication of changes in heating-system performance. Overall, the results suggest improved energy performance of FBL's own heating system during most of the analysed implementation period. This trend is consistent with the Pilot Action's objective of systematically monitoring and improving heating-related energy use through the implementation of ISO 50001.

In addition to FBL's own natural gas consumption, the analysis also considers the 7 Points of Delivery (PODs) associated with natural gas consumption. Figure 43 presents their consumption of natural gas normalized by HDD.

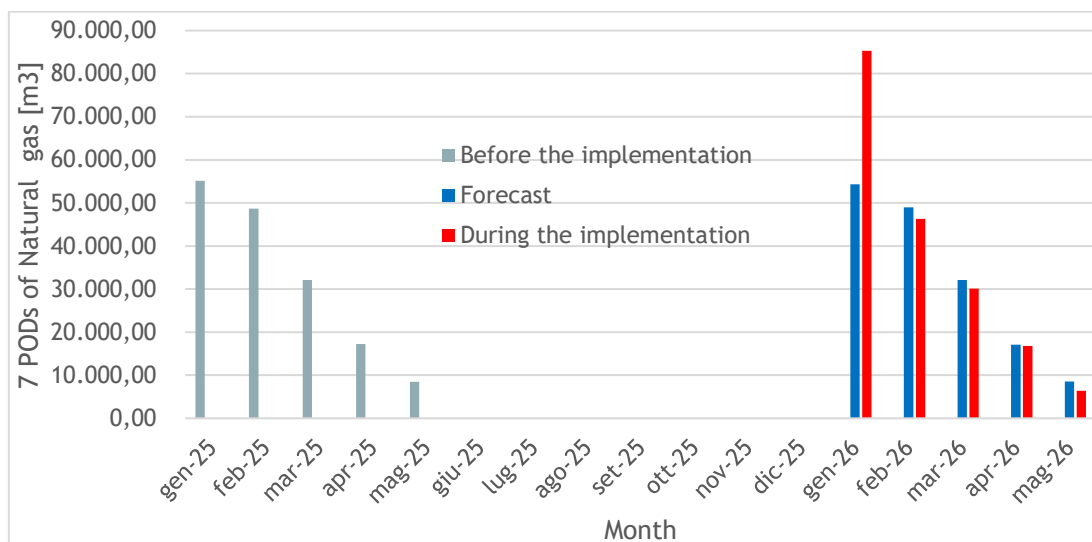


Figure 43: Consumption of natural gas (7 PODs) - waterway transport

The most notable deviation is observed in January 2026, when the actual natural gas consumption was substantially higher than the forecast value. From February to May, however, the measured consumption remained below the respective forecast values, with relatively moderate differences in February, March and April and a more visible reduction in May. The results therefore indicate that, after the initial increase in January, the natural gas consumption of the 7 PODs generally performed better than expected under comparable heating conditions during the remaining implementation period. Since HDD normalization accounts for variations in outdoor temperature, the lower consumption observed from February onwards provides an indication of improved heating-related energy performance rather than simply reflecting milder weather conditions. Nevertheless, the considerable increase observed in January demonstrates that the improvement was not uniform throughout the implementation period and highlights the importance of continuous monitoring within the ISO 50001 framework.

The following indicator evaluates electrical energy consumption at the 12 relevant PODs. Figure 44 presents the comparison of electrical energy consumption normalized by HDD.

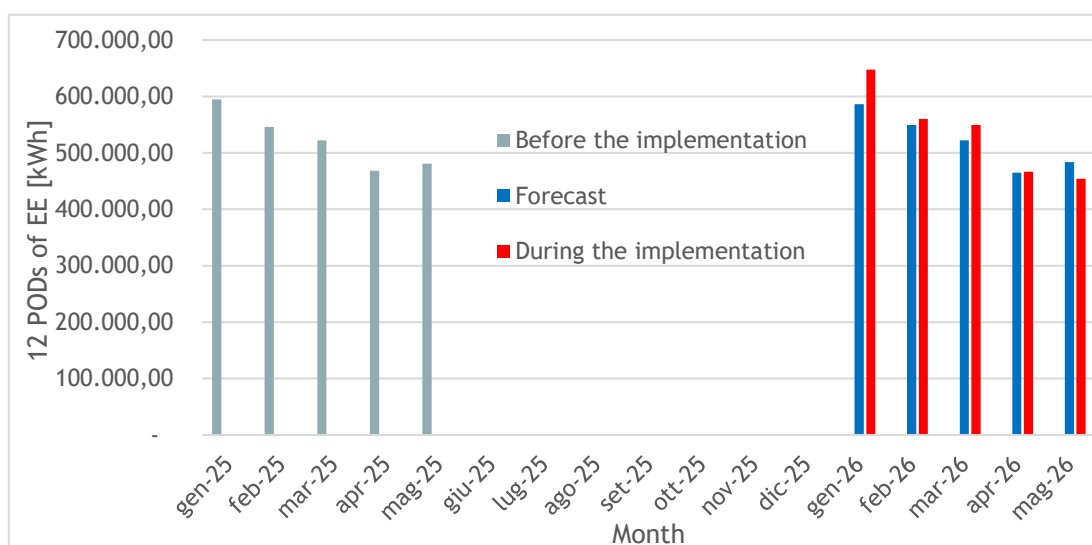


Figure 44: Electrical energy consumption (12 PODs) - waterway transport



Compared with the natural gas indicators, the electricity consumption of the 12 PODs shows less uniform development during the implementation period. In January 2026, actual consumption was noticeably higher than forecast, reaching approximately 648,000 kWh compared with a forecast of around 580,000 kWh. In February, the difference was considerably smaller, with actual consumption only slightly exceeding the forecast. A similar increase was observed in March, when actual consumption again remained above the expected value. In April, the actual and forecast values were almost identical, indicating performance close to the baseline expectation. Finally, in May, actual electricity consumption fell below the forecast value, representing the most favourable result within the analysed period.

The monthly development therefore shows a gradual improvement during the implementation period. While electricity consumption was initially higher than expected, the difference between actual and forecast consumption generally decreased over the following months, eventually resulting in lower-than-forecast consumption in May. This development may indicate that the effects of the energy management measures became more visible as the implementation progressed.

4.4.2.2. Outdoor lighting efficiency

Outdoor lighting represents another area directly controlled by FBL. Unlike heating-related energy consumption, this indicator is not normalised by HDD, since lighting demand is not directly influenced by outdoor temperature. Instead, the evaluation considers electricity consumption in relation to operating conditions and lighting schedules. Figure 45 presents the change in outdoor lighting consumption between the baseline and EMS implementation periods.

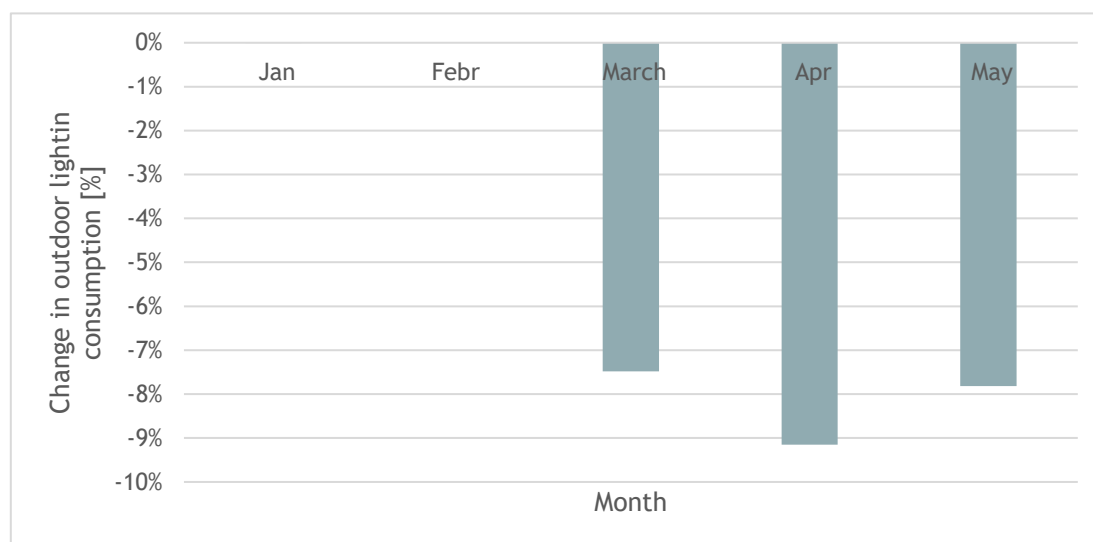


Figure 45: Change in outdoor lighting consumption between the baseline and EMS implementation periods - waterway transport

No significant change was observed in January and February, while reductions were recorded from March onwards, with decreases of approximately 8-9% in March, April and May.

The outdoor lighting EnPI was designed to account for the lighting system's operating hours and control settings. Electricity consumption data from individual PODs are combined with information on the number and rated power of installed luminaires. In addition, the lighting schedule follows the switching times defined by the MSZ 20194-1:2000 standard, thereby accounting for seasonal differences in daylight duration.



4.4.2.3. Fleet fuel consumption

Fuel consumption of FBL's employee vehicle fleet was also monitored during the Pilot Action. Figure 46 presents the monthly change in combined gasoline and diesel consumption between the baseline and implementation periods.

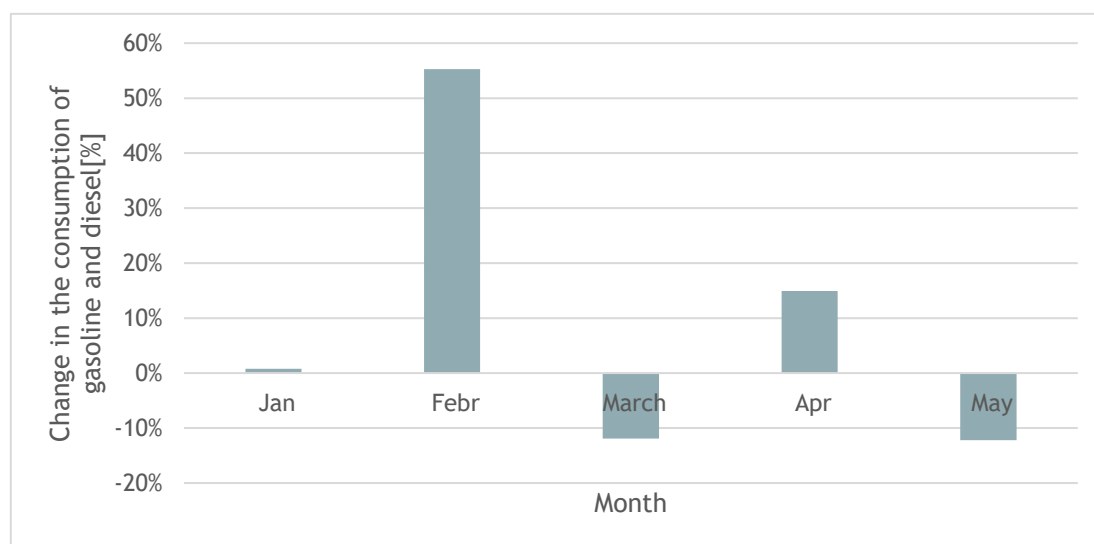


Figure 46: Monthly change in the combined consumption of gasoline and diesel between the baseline and implementation periods - waterway transport

The results show considerable monthly variability, with increases recorded in some months and reductions in others. However, unlike the heating and outdoor lighting indicators, no quantitative energy-efficiency improvement target was defined for fleet fuel consumption.

The vehicle fleet represents only a very small share of FBL's overall energy consumption, while its fuel demand is largely determined by variable and ad hoc business travel requirements. Consequently, changes in fuel consumption primarily reflect changes in travelled distance and operational activity rather than improvements or deterioration in energy efficiency.

For this reason, the observed increase or decrease in fuel consumption should not be interpreted as a direct measure of EMS performance. The indicator is primarily relevant for monitoring purposes and for identifying potential future opportunities, while a reduction in fuel use resulting solely from fewer business trips would not represent an energy-efficiency improvement in the context of the Pilot Action.

4.4.3. EMS Pilot Action Values

Overall, the comparison against the baseline indicates that the implementation of ISO 50001 at the Freeport of Budapest established a more systematic framework for evaluating and improving the energy uses that can be directly influenced by FBL. Since more than 90% of the port's overall energy consumption is attributable to tenants, the defined EnPIs appropriately focus on the remaining share under FBL's direct operational control.

The most relevant improvements were observed in heating-related natural gas consumption. HDD-normalized indicators generally showed lower consumption during the EMS implementation period, indicating improved heating-system performance independently of variations in weather conditions. Outdoor lighting also showed favourable developments, particularly from March to May. The dedicated



lighting EnPI further strengthens the evaluation by accounting for operating hours, installed lighting capacity and seasonal variations in daylight.

Electricity consumption across the monitored PODs showed greater variability and therefore does not demonstrate a uniform improvement across all months. Nevertheless, the availability of detailed POD-level monitoring supports the ISO 50001 objective of identifying deviations and enabling targeted corrective actions.

Fleet fuel consumption should be interpreted differently from the other indicators. Since no quantitative improvement target was established and consumption is strongly dependent on variable business travel requirements, changes in gasoline and diesel consumption cannot be considered a direct measure of energy-efficiency improvement. Its monitoring nevertheless contributes to the broader energy-management framework and may support the identification of future optimization opportunities.

Overall, the results demonstrate that the principal value of the FBL Pilot Action lies not only in the observed reductions in selected energy uses but also in the establishment of a structured and verifiable energy-management approach. The use of appropriately defined EnPIs, normalization methods and continuous monitoring support the Plan-Do-Check-Act principle of ISO 50001 and provides FBL with a basis for continuous improvement beyond the duration of the Pilot Action.



5. Cross-Pilot Analysis

The pilot action implemented under Activity 2.3 was carried out through four test sites, one for each transport mode addressed by the project: Adriafer (rail transport, Trieste), Dubrovnik Airport (DBV, air transport), GMK Kraków (urban transport, Górka Narodowa P&R facility) and Freeport of Budapest Logistics (FBL, waterway transport). As set out in the earlier deliverables, these are the four test sites of a single pilot action, each running a mode-specific EMS package derived from the common framework of Activity 2.1. What the sites share for the purposes of this evaluation is the methodology and the monitoring and KPI templates; recurring patterns across sites are therefore read as evidence about that shared method, while site-specific outcomes reflect each package and its local context.

This chapter is a qualitative cross-pilot analysis, and its primary source is the set of "before/after" self-assessment grids completed by each test site (the EMS Pilot Action values workbooks). In these grids every organisation scored itself, before and after the pilot, on a common set of dimensions – human resources engaged, procedures in place, standards in place, software in place, KPIs and data collection, training, and the capability to improve efficiency. Each dimension is broken down into individual elements scored on a simple maturity scale, and the dimension total is the sum of its elements, so the headline figures can exceed 1. The grids also carry an explanatory note for most elements, and those notes are used here as qualitative evidence alongside the scores. What matters throughout is the direction and character of the change from the "before" to the "after" state, not the absolute number.

Two further sources support this qualitative core. The quantitative monitoring data collected monthly through the common templates and consolidated on the Power BI platform described in Chapter 2 provide the measured outcomes where these are available. The four pilot testing visits (Activity 2.4), one at each implementation site – airport (Dubrovnik), waterway (Budapest), railway (Trieste) and urban (Kraków) – provide direct observation of how each mode implemented its EMS; the visit hosted by FBL at the Freeport of Budapest in March 2026, with the participation of Port Ploče, is one of the four. The partner presentations and software screenshots (shown in chapter 7 - Annexes) are used as subordinate evidence, to illustrate and corroborate the grids rather than to drive the analysis.

Table 9: Overview of the four test sites of the pilot action.

Test site	Transport mode	Country	Facility / scope
Adriafer - Trieste	Rail	Italy	Shunting operations, 6 locomotives
DBV - Dubrovnik Airport	Air	Croatia	Airport terminal and HVAC (6 heat pumps as SEU)
GMK - Kraków	Urban	Poland	Górka Narodowa Park & Ride facility
FBL - Freeport of Budapest Logistics	Waterway	Hungary	Port facility, 12 electricity + 7 gas PODs

Table 5.2 gives a cross-site synthesis of the self-assessment dimensions, showing the before and after totals recorded by each site. The six thematic sections that follow – economic benefits, internal awareness, ISO compliance, organisational improvements, monitoring systems and governance aspects – read these results across the four sites.

Table 10: Cross-site synthesis of the self-assessment grids: dimension totals before and after the pilot (sum of element scores; higher = more established).

Dimension	Adriafer	DBV	Kraków	FBL
Human resources	0.7 → 3.2	1.2 → 1.8	1.1 → 1.6	see §5.4
Procedures in place	0.7 → 3.6	2.0 → 5.0	2.0 → 3.5	2.0 → 5.5



Dimension	Adriafer	DBV	Kraków	FBL
Standards in place	2.5 → 3.5	4.0 → 4.0	1.0 → 1.0	2.0 → 3.0
Software in place	0.0 → 2.4	2.0 → 3.0	0.0 → 1.0	0.0 → 1.0
KPIs and data collection	0.3 → 3.8	3.0 → 6.2	1.2 → 8.0	3.0 → 6.0
Training	0.0 → 1.0	0.0 → 3.0	0.0 → 2.0	0.0 → 2.0
Capability to improve efficiency	improved	0.8 → 0.9	0.4 → 0.9 (subj.)	improved

5.1. Economic benefits

The economic benefits of the pilot fall into two groups: direct, measured savings at the sites that implemented a consumption or fuel change during the window, and enabling gains at the sites that invested first in the capability from which savings follow. The self-assessment grids capture the second; the quantitative templates capture the first.

At Adriafer the transition of the shunting fleet from diesel to HVO produced the clearest measured return of the pilot. On the technical-economic baseline (six locomotives, 2,680 hours 42 minutes of service and 2,088 shunting operations between 27 June and 30 September 2025, annualised over 11,794 operating hours), annual fuel consumption falls from 162,757 to 97,890 litres, annual expenditure from €201,656 to €119,034 (a saving of €82,622 per year), and annual CO₂ emissions from 436.2 to 52.9 tonnes, with NO_x -55%, PM -60% and maintenance waste -36% in parallel.

Table 11: Adriafer measured economic and environmental impacts (quantitative template).

Indicator	Baseline	Pilot result	Improvement
Annual fuel consumption	162,757 L	97,890 L	64,867 L saved
Annual expenditure	€201,656	€119,034	€82,622 saved
Annual CO ₂ emissions	436.2 t	52.9 t	383.3 t avoided
Fuel per hour	13.8 L/h	8.3 L/h	-39.85%
NO _x	394 ppm	180 ppm	-55%
PM	41 µg/m ³	16 µg/m ³	-60%
Maintenance waste	502 kg	320 kg	-36%

At DBV and Kraków the economic benefit is enabling rather than immediate, because both sites invested first in metering and analytical capacity from which savings follow. At DBV the measured outcome already appears in the energy performance indicator adopted under ISO 50001 (electricity per passenger), which improved from 3.28 kWh/passenger in the 2024 baseline to 3.06 in 2026; the partner expects the larger effect during the cooling season, outside the testing window, since the HVAC system is the significant energy use and the window covered the heating season. At Kraków the value created is best expressed through the Smart Readiness Indicator, assessed with the official European Commission tool (SRI_calculation-sheet_v4.5): the overall SRI score for the Górka Narodowa facility rose from 0.202 to 0.302, with the "Energy Efficiency and Operational Reliability" domain improving from 0.255 to 0.420. These are genuine enabling gains: they establish the conditions under which savings are identified and captured in the cycles that follow.

Table 12: DBV energy performance indicator (EnPI): electricity per passenger.

EnPI - electricity (kWh/passenger)	2024 (baseline)	2025	2026
DBV average	3.28	3.10	3.06

At FBL the same data capability was applied to the consumption under the Freeport's direct control. Comparing January-May 2026 with the same months of 2025 on a heating-degree-day (HDD) normalised



basis, own natural-gas consumption fell to 0.61 of baseline (about –39%), own electricity to 0.61 (about –38.6%) and outdoor lighting to 0.76 (about –24.5%). These results show that the energy-reduction targets defined in section 3.4.1 were substantially exceeded for both heating systems and outdoor lighting, where reductions of 8% and 5%, respectively, had originally been targeted. Fleet gas oil and diesel rose to 1.08 of baseline; because the monitoring made this visible, it becomes an item FBL can act on in the next phase. However, this increase was partly influenced by additional fuel consumption associated with travel by car to project pilot visits. FBL focused its binding targets on the roughly 10% of consumption it operates directly, while building the monitoring foundation to engage tenants, who account for most of the remaining use, through monthly statements.

Table 13: FBL measured energy outcomes, HDD-normalised (baseline Jan-May 2025 = 1.00).

Consumption (FBL-controlled)	Baseline	Achieved	Approx. change
Own natural gas (7 PODs)	1.00	0.61	–39%
Own electricity (12 PODs)	1.00	0.61	–38.6%
Own outdoor lighting	1.00	0.76	–24.5%
Own gas oil and diesel (fleet)	1.00	1.08	+7.8% (to consolidate next phase)

5.2. Internal awareness

Internal awareness is captured in the grids chiefly through the training dimension, and here the result is simple and telling: structured EMS training did not exist at any of the four sites beforehand, and all four introduced it during the pilot, each rising from a starting value of zero. Training is the dimension where the "before" state was most uniformly empty, so any movement represents a genuinely new capability rather than the reinforcement of an existing one.

DBV recorded the highest training total, 0 to 3.0, covering EMS training sessions, EMS customisation, HVAC-unit improvement work and Schneider PME training. FBL and Kraków each moved from 0 to 2.0: FBL through EMS-customisation awareness-raising and dedicated software training for operational staff, Kraków through EMS customisation and EMS-operation training. Adriafer recorded 0 to 1.0, its training resuming during the pilot period. The grid notes at FBL connect this directly to the workload change discussed under organisational improvements below: structured training is what allowed automated tools to take over manual tasks without loss of control.

Table 14: Training and awareness introduced during the pilot (all sites from a zero baseline).

Site	Before After	→ Training introduced
Adriafer	0.0 → 1.0	EMS training resumed during the pilot
DBV	0.0 → 3.0	EMS sessions, EMS customization, HVAC improvement, PME training
Kraków	0.0 → 2.0	EMS customization and EMS-operation training
FBL	0.0 → 2.0	EMS-customization awareness and software training

Because awareness is the first thing an organisation gains and the most transferable, this dimension matters out of proportion to its numerical size: it is the mechanism by which the capabilities recorded in the other dimensions become usable by people rather than remaining features of software. Across the four sites the pilot converted energy management from something a few individuals attended to into shared, trained knowledge.



5.3. ISO compliance

The standards dimension shows the smallest movement, and for a positive reason: it largely reflects the certification each organisation already held, which the grids treat as the necessary background for an EMS rather than as something the pilot was meant to create. The values therefore say more about starting conditions than about pilot activity – with one important exception, FBL's ISO 50001 certification obtained in December 2025 while during the testing phase lasted from January to April 2026.

DBV records the highest and most stable standards position, 4.0 before and after, holding an environmental strategy together with ISO 14001, ISO 50001 and ISO 9001; its grid notes describe these as the background for an efficient system, with no further certification needed. The pilot's contribution at DBV was therefore not to add standards but to operationalise them. The most significant standards movement is at FBL, from 2.0 to 3.0, driven by the successful adoption of ISO 50001 during the pilot – the grid records this element moving from 0 to 1 – alongside its existing ISO 9001, while ISO 14001 was noted as outside the scope of this pilot. Adriafer rose from 2.5 to 3.5, formalising its environmental strategy and beginning ISO 50001 adoption (0 to 0.5) on top of established ISO 14001 and ISO 9001. Kraków remained at 1.0, holding an environmental strategy as its background condition.

Table 15: Standards in place before and after the pilot, by test site.

Site	Before After	→ Standards position (from the grid)
DBV	4.0 → 4.0	ISO 14001, ISO 50001, ISO 9001 and strategy already in place
Adriafer	2.5 → 3.5	ISO 14001 and ISO 9001 held; ISO 50001 adoption begun; strategy formalized
FBL	2.0 → 3.0	ISO 50001 adopted during the pilot; ISO 9001 held
Kraków	1.0 → 1.0	Environmental strategy in place as background condition

FBL's ISO 50001 certification is the clearest single compliance achievement of the pilot, and the Pilot Concept documents the pathway in enough detail to serve as a replicable template for organisations approaching ISO 50001 without prior environmental certification. The process ran over roughly five months of preparation followed by an external audit, with official certification on 15-17 December 2025.

Table 16: ISO 50001 implementation pathway at the FBL test site.

Phase	Period	Lead actor
EMS (EglR) team, energy policy, basic training, data collection plan	Jul-Aug 2025	Operational project coordinator / ISO consultant
Organizational context, stakeholders, risk assessment, audit schedule	Aug 2025	Operational project coordinator
Baseline and scope definition, meter inventory, energy map, EnPI identification	Sep 2025	Operational project coordinator
Objectives and action plan; corrective documentation	Sep-Oct 2025	Operational project coordinator
Management review and internal control audit	Oct-Nov 2025	ISO consultant
Implementation of customized EMS software	Oct 2025	Operational project coordinator
Pre-audit and official certification audit	Nov-Dec 2025	ISO certification body
Pilot operational testing, data analysis and validation	Jan-Apr 2026	Operational project coordinator and ISO consultant



FBL also engaged external expertise to compensate for the absence of in-house EMS experience, including benchmarking with a peer organisation already certified according to ISO 50001 (ÁTI Depo Zrt.), external ISO consultancy, and support from an energy-procurement coordinator. This combination of peer learning and external expertise represents a transferable support model for organisations or sectors seeking to implement ISO 50001 without extensive prior in-house experience.

5.4. Organisational improvements

Organisational improvement is visible in two grid dimensions read together: human resources engaged and procedures in place. The first records how far environmental management became a defined responsibility of identified people; the second records how far it became embedded in documented routine. Both moved substantially at every site.

On human resources, the most pronounced change is at Adriafer, from 0.7 to 3.2, as environmental and ESG coordination moved from limited to active and the operations, maintenance and DORIS digital-support teams were all drawn into the EMS. DBV rose from 1.2 to 1.8 across the development director, an environment specialist, the maintenance director and the HVAC and electrical heads, and Kraków from 1.1 to 1.6 across technology, administration, property management and IT. FBL is the instructive case: management commitment and involvement rose from 0.7 to 0.9, while the operational-staff and maintenance workload fell from 0.8 to 0.3 because automated diagnostics and data collection replaced manual tracking – senior engagement up, routine manual burden down, which is precisely the shift an EMS is intended to produce.

On procedures, every site more than doubled its total, and the elements added are strikingly similar across the four modes, which is itself evidence that the shared framework guided implementation in a consistent direction. FBL moved from 2.0 to 5.5 and DBV from 2.0 to 5.0, in both cases adding monthly analyses of energy and emissions, a regular multi-departmental review meeting and partly implemented hourly/daily gap analysis to a base that previously held only annual reviews; the grid notes make the logic explicit ("more data = more procedures = better efficiency"). Adriafer rose from 0.7 to 3.6, adding monthly analyses, quarterly meetings, voluntary ESG preparation and an HVO fuel procedure; Kraków rose from 2.0 to 3.5, adding periodic EMS review meetings. The procedures added are the ones that turn monitoring data into management routine, so this is where the EMS most clearly became embedded in how each organisation works.

Table 17: Organizational improvement: human resources and procedures totals.

Site	Human resources	Procedures	Character of the change
Adriafer	0.7 → 3.2	0.7 → 3.6	Cross-functional teams drawn in; monthly analyses, ESG prep, HVO procedure
DBV	1.2 → 1.8	2.0 → 5.0	More coordination; monthly analyses and review meeting
FBL	commitment 0.7 → 0.9	2.0 → 5.5	Senior engagement up, manual workload down; documented procedures
Kraków	1.1 → 1.6	2.0 → 3.5	Wider involvement; periodic EMS review meetings

The same two procedural elements – hourly/daily gap analysis and, at some sites, monthly emissions analysis – are the ones most often scored as only partly implemented, which identifies them as the natural focus for consolidation in the next phase. Taken together, the two dimensions show the pilot turning environmental management from a task resting on individual goodwill into a defined organisational function supported by documented routine.



5.5. Monitoring systems

Monitoring systems are captured in the grids through two dimensions: software in place and KPIs and data collection, and this is where the pilot shows its largest and most decisive gains. The capability built here – the ability to see energy use at finer time resolution and disaggregated by consumer – is the precondition for the economic benefits discussed above and for the efficiency measures that will follow in later cycles.

On software, the pattern is that the sites that started with the least gained the most. Adriafer moved from 0.0 to 2.4 (IoT edge-to-core-to-cloud integration, a local EMS analysis tool and a cloud application), Kraków and FBL each from 0.0 to 1.0 with their first dedicated monitoring and data-acquisition software, and DBV from 2.0 to 3.0, adding a local EMS analysis tool to the Schneider PME metering and cloud software it already operated. Three of the four sites had no dedicated analytical software beforehand, and all four finished with an operational tool.

On KPIs and data collection – the single largest gain of any dimension in the grids – the grid notes across all four sites repeat the same logic, "more data = more KPIs". Kraków records the steepest rise, from 1.2 to 8.0, moving from macro-level yearly and monthly consumption to per-user consumption, daily/hourly/15-minute comparisons, real-time power data for the whole P&R site and for individual users, weather correlation and new communicating meters, supporting real-time anomaly detection. DBV rose from 3.0 to 6.2, Adriafer from 0.3 to 3.8 and FBL from 3.0 to 6.0, the FBL notes recording that expanded sub-metering is what allowed the Freeport to attribute consumption to individual points. The common thread is a shift from annual, whole-site figures to high-resolution, disaggregated data.

Table 18: Monitoring systems: software and KPI/data-collection totals.

Site	Software	KPIs and data	Capability added
Kraków	0.0 → 1.0	1.2 → 8.0	Per-user and 15-minute data, real-time power, weather correlation
DBV	2.0 → 3.0	3.0 → 6.2	Monthly/daily comparison; monthly emissions; new metering
Adriafer	0.0 → 2.4	0.3 → 3.8	IoT integration; monthly energy and emissions
FBL	0.0 → 1.0	3.0 → 6.0	On-demand daily comparison; expanded sub-metering

The FBL case is worth singling out for the quality of the monitoring its EMS package delivers. Beyond simply recording consumption, the EMS platform provides near-instantaneous monitoring at a level of detail and precision that turns energy into a fully manageable variable: consumption is visible for each Point of Delivery at 15-minute resolution and effectively in real time, which allows the Freeport to inform any operational choice with current data rather than after-the-fact figures. This granularity supports decisions that were previously impossible to make with confidence – for example, whether at a given moment it is more economical to use self-generated energy directly or to draw energy from the grid and store it for later use. In this sense the software score recorded in the grid understates the operational value delivered: the capability is not only to see consumption, but to act on it while it is happening.

5.5.1. The EMS software platforms behind the scores

The software and KPI scores have concrete instances in the platforms each partner deployed, described here as subordinate, illustrative evidence. At Adriafer the gain is embodied in DORIS EMS, a customised environmental digital layer integrated into the DORIS operational rail control-room



platform, providing environmental monitoring, ESG KPI generation and EMS operational support, organised into modules whose functions correspond directly to the grid dimensions.

Table 19: DORIS EMS main software modules (Adriafer).

Module	Main function
Fuel Monitoring	HVO and diesel tracking
Emission Engine	Scope 1 CO ₂ calculations
Environmental Dashboard	KPI visualization
Maintenance Layer	Waste and maintenance monitoring
Audit Layer	EMS procedures and compliance
Reporting Engine	ESG and REDU-CE-D reports
Operational Analytics	Trends and operational analysis

The partner presents DORIS EMS as the REDU-CE-D beta version, with planned evolution towards AI-supported analytics, predictive maintenance, real-time emissions estimation, automated ESG export, Scope 2 electricity monitoring and CSRD-aligned modules; emission accounting currently covers Scope 1 and 2, with Scope 3 identified as a future development. At DBV the software and standards scores rest on a three-step architecture the partner set out explicitly – ISO 50001 defined the significant energy use and the EnPI framework, Schneider PME enabled automated metering, and a customised EMS layer supplied by Kolektor added the data analysis, trends and forecasting that PME alone did not provide. The partner estimates basic-level integration at a minimum of six months and mid-level integration at twelve to twenty-four months, an evidence-based expectation for any organisation replicating the package.

Table 20: The three-step architecture of the customised EMS at DBV.

Step	Date	Component	Function delivered
1	11/2025	ISO 50001	Defined the significant energy use (SEU) and the EnPI framework
2	12/2025	Schneider PME	Enabled automated metering of the SEU
3	01/2026	Customized EMS (Kolektor)	Data collection, analysis, trends and forecasting

At FBL the gains are embodied in the EMS platform, which manages 23 Points of Delivery across two sites and 36 facilities – 14 electricity and 9 gas PODs – with 21 of the 23 delivering time-series data, each POD named after the building or activity it serves so that consumption can be disaggregated by significant energy user. Its views include multi-year monthly and cumulative electricity comparison (2020-2026), stacked daily consumption by individual POD and a quarter-hourly load curve. This is the operational instrument behind the FBL results.

5.6. Governance aspects

Governance concerns how each Environmental Management System is owned, staffed and reviewed. The grids and pilot concepts show that all four partners moved environmental management from an informal task to a defined responsibility, each through a different arrangement.

DBV set out a clear structure, defining four EMS roles – EMS integration (IT and Energy departments jointly), EMS administration (Head of the Energy department), EMS user trainees (the Energy Optimisation Team with the training centre) and EMS users (high and mid management) – and its capability-to-steer assessment rose from 0.8 to 0.9.



Adriafer spread accountability across its ESG coordination, operations, maintenance and DORIS digital-support teams, so that environmental data collection was embedded in the functions that generate the impacts.

FBL placed operational coordination with its Operations Manager, supported by external ISO consultants, and its grid records management commitment and involvement rising from 0.7 to 0.9 – direct evidence of the top-management commitment that ISO 50001 requires.

Kraków distributed roles across its technology, administration, property-management and IT functions, with its capability-to-steer judgement rising from 0.4 to 0.9.

Across all four sites the pilot also introduced, from a baseline of none, periodic EMS review meetings that institutionalise the plan-do-check-act cycle, while project-level supervision under REDUCED WP2 and the supporting-partner pairing (BUD-DBV, Port Ploče-FBL, ECCO-rail-Adriafer, BKK-Kraków) kept each site aligned with the common EMS framework.

One useful way to summarise the governance outcome of the pilot is to condense each site's self-assessment grid into a single overall figure, here called the Qualitative Progress score. It is obtained by summing the dimensions of the grid before and after the pilot, so that a higher figure means an improved and more established environmental-management system. The score is not normalised: because it is a sum of element scores, its absolute value depends on how many dimensions each grid contains, so the meaningful reading is the movement from the "before" to the "after" state and the resulting growth factor.

Values are taken directly from the xls files where the partner computed it, and calculated by the evaluation team, using every dimension recorded in that site's grid, where it was not. Because each grid contains a slightly different set of dimensions, the tables below show, for every partner, exactly which grid rows enter its score.

Table 5.13 - DBV: dimensions summed for the Qualitative Progress score (EMS_PILOT_Action_values_DBV.xlsx, "Air transport").

Dimension (grid row)	Before	After	%
Human resources directly involved	1.2	1.8	+50%
Procedures in place	2.0	5.0	+150%
Standards in place	4.0	4.0	+0%
Software in place	2.0	3.0	+50%
KPIs and data collection	3.0	6.2	+107%
Training sessions for EMS	0.0	3.0	new
Capability to improve efficiency	0.8	0.9	+12%
AI compatibility upgrade	0.5	0.6	+20%
Total (Qualitative Progress)	13.5	24.5	+81%

At DBV the strongest gains are in procedures (+150%) and KPIs and data collection (+107%), the two dimensions that turn monitoring into routine management. Standards were already fully in place and did not move, so the overall +81% reflects new capability added on top of a mature certification base.

Table 5.14 - FBL: dimensions summed for the Qualitative Progress score, as computed in the partner's own workbook (EMS_PILOT_Action_values_FBL.xlsx, "Joint template").

Dimension (grid row)	Before	After	%
Management commitment & involvement (+)	0.7	0.9	+29%
Operational staff involvement & workload (-)	0.8	0.3	-62%
Procedures in place (+)	2.0	5.5	+175%
Standards in place (+)	2.0	3.0	+50%
Energy management software & IT tools (+)	0.0	1.0	new
KPIs and data collection (+)	3.0	6.0	+100%
Training & awareness sessions (+)	0.0	2.0	new



Dimension (grid row)	Before	After	%
Total (Qualitative Progress, partner value)	6.9	18.1	+162%

FBL combines a rise in management commitment (+29%) with a 62% fall in operational-staff workload, the latter counting as an improvement because manual tracking was replaced by automation. Procedures (+175%) and the first dedicated energy-management software drive the +162% overall, consistent with the ISO 50001 adoption completed during the pilot.

Table 5.15 - Adriafer: dimensions summed for the Qualitative Progress score (EMS_PILOT_Action_values_ADRIAfer.xlsx, "Foglio1").

Dimension (grid row)	Before	After	%
Human resources directly involved	0.7	3.2	+357%
Procedures in place	0.7	3.6	+414%
Standards in place	2.5	3.5	+40%
Software in place	0.0	2.4	new
KPIs and data collection	0.3	3.8	+1167%
Training sessions for EMS	0.0	1.0	new
Total (Qualitative Progress)	4.2	17.5	+317%

Adriafer shows the steepest growth of the four sites, starting from the lowest base: KPIs and data collection rise more than twelvefold (+1167%) and procedures more than fivefold (+414%). The +317% overall reflects an EMS built essentially from scratch, with new software and structured data where almost none existed before.

Table 5.16 - Kraków: dimensions summed for the Qualitative Progress score (EMS_PILOT_Action_values_Kraków.xlsx, "Urban transport").

Dimension (grid row)	Before	After	%
Human resources directly involved	1.1	1.6	+45%
Procedures in place	2.0	3.5	+75%
Standards in place	1.0	1.0	+0%
Software in place	0.0	1.0	new
KPIs and data collection	1.2	8.0	+567%
Training sessions for EMS	0.0	2.0	new
SRI Assessment	2.483	3.945	+59%
Subjective capability to improve efficiency	0.4	0.9	+125%
Total (Qualitative Progress)	8.183	21.945	+168%

At Kraków the largest single gain is in KPIs and data collection (+567%), supported by a rise in the Smart Readiness Indicator (+59%) and a doubling of the self-assessed capability to steer efficiency (+125%). The +168% overall confirms a facility that moved from a simple monitoring baseline to an actively managed system.

Brought together, the four scores give a compact cross-site picture of how far each environmental-management system matured over the pilot.

Table 5.17 - Overall Qualitative Progress by test site.

Test site	Before	After	Variation %
DBV (air)	13.5	24.5	+81%
FBL (waterway)	6.9	18.1	+162%
Adriafer (rail)	4.2	17.5	+317%
Kraków (urban)	8.183	21.945	+168%



Every site increased the maturity of its environmental-management system, with the largest relative growth at Adriafer (+317%), which started from the lowest base, and the smallest at DBV (+81%), which started from the most mature one. Because each grid includes the dimensions most relevant to its own context the totals are best read together with the per-site tables above, which make the composition of each score and increased performance explicit.

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6. Conclusions and Recommendations for EMS Support Package Development

This final chapter draws together the evidence presented in Chapters 3 to 5 and translates it into an assessment of what the customised EMS support packages achieved during the pilot action, where they can develop further, how far they can be transferred to other organisations and transport modes, and what should inform the finalisation of the packages.

One overarching conclusion frames everything that follows. The pilot action did produce immediate and substantial financial savings, particularly at two of the four test sites and only where the EMS was coupled with a specific operational or fuel-switching intervention. The principal and most widely shared benefit was of a different nature: the introduction of good-practice procedures and of systematic data collection and monitoring. These generate, first and foremost, awareness of actual consumption – an awareness that in most of the participating organisations did not exist in usable form beforehand – and it is that awareness which subsequently makes it possible to take informed decisions aimed at saving energy and increasing efficiency. The savings recorded are the visible outcome; the monitoring capability established at all four test sites is the durable one, and it is the precondition for savings not yet measured because the observation window closed before they could manifest with a trend.

Read across the six themes of the cross-pilot analysis, the four grids tell a consistent story. The largest and most uniform gains are in monitoring systems and in the procedures that turn monitoring into routine; internal awareness rose from zero everywhere; organisational engagement grew most where the starting point was lowest, ISO compliance moved least, because it largely reflects pre-existing certification, with the notable exception of FBL's ISO 50001 adoption during the pilot and governance capability rose wherever it was assessed. The theme the evaluation treats as decisive is monitoring systems, because it is the precondition for everything else: the self-assessed leap in KPIs and data collection (Kraków 1.2 to 8.0, Adriafer 0.3 to 3.8, DBV 3.0 to 6.2, FBL 3.0 to 6.0) is what turned energy from an annual accounting figure into a managed variable, and it is the demonstrated strength of the mode-specific customisation approach of Activity 2.2: four independent packages, guided by one common framework, produced the same core capability gain across four very different transport environments.

Table 6.1 - Distribution of benefits across the four test sites: immediate savings versus capability building.

Type of benefit	DBV	FBL	Adriafer	Kraków
Immediate financial saving	Emerging	Yes	Yes	Deferred
Procedures introduced or formalized	Yes	Yes	Yes	Yes
Monitoring and data collection expanded	Yes	Yes	Yes	Yes
Staff awareness and training increased	Yes	Yes	Yes	Yes
Review cycle (PDCA) institutionalized	Yes	Yes	Yes	Yes
Perceived capability to improve efficiency	0.8 → 0.9	Improved	Improved	0.4 → 0.9
Energy performance indicator improved	Yes (EnPI)	Yes	Yes	SRI

6.1. Strengths

Several strengths of the customised EMS support packages emerge consistently from the evidence collected at the four test sites. The single most important, and the one common to every site irrespective of sector, size or certification status, is the establishment of a data and monitoring foundation. Beforehand, three of the four organisations produced energy figures only on an annual or monthly basis; afterwards, all four operate monitoring systems capable of monthly reporting and three of daily, hourly or real-time resolution. The decisive change was not the existence of



measurement but its granularity and automation – disaggregation by consumer group and significant energy user, automatic acquisition replacing manual transcription, and the ability to compare periods and detect anomalies, which is what converts energy from an annual invoice into a manageable operational variable.

Table 6.2 - Growth in KPI and data collection capability across the pilot action.

Test site	Before	After	Growth factor
Kraków (urban)	1.2	8.0	× 6.7
Adriafer (rail)	0.3	3.8	× 12.7
DBV (air)	3.0	6.2	× 2.1
FBL (water)	3.0	6.0	× 2.0

This foundation produced an immediate effect on internal awareness, reported at every test site and quantified by the engagement indicators: human resources directly involved rose from 0.7 to 3.2 at Adriafer, from 1.2 to 1.8 at DBV and from 1.1 to 1.6 at Kraków, and training sessions were introduced from a zero baseline everywhere. The Kraków subjective assessment of the capability to improve efficiency rose from 0.4 to 0.9 and the DBV assessment from 0.8 to 0.9, in both cases before any direct consumption-reduction measure was implemented.

Where the EMS was combined with a concrete intervention, returns were immediate and large. Adriafer reduced annual fuel consumption by 64,867 litres and annual expenditure by €82,622, avoiding 383.3 tonnes of CO₂, with normalised indicators (–39.85% per hour, –39.5% per shunting operation) confirming a genuine operational effect rather than a demand artefact; FBL achieved reductions of 39% in gas, 38.6% in electricity and 24.5% in outdoor lighting within its controlled perimeter, substantially exceeding its own targets. These results establish that the packages are not merely documentary instruments and provide the business case needed to justify replication. Furthermore, the implementation of the EMS, which enables energy consumption to be monitored at 15-minute intervals, provides FBL not only with greater visibility of its energy use but also with the ability to identify deviations and respond to them as they occur.

The packages also proved adaptable to different organisational baselines, delivering measurable results in a triple-certified airport and in a port holding no ISO 14001, in a six-locomotive shunting fleet and in a single park-and-ride building; FBL implemented ISO 50001 in December 2025 (while testing started in January 2026) without prior environmental certification, demonstrating that a mode-specific package does not presuppose an existing management-system infrastructure. Finally, the packages achieved structural embedding through procedures and governance: documented procedures increased at every site – from 2.0 to 5.5 at FBL, 2.0 to 5.0 at DBV, 0.7 to 3.6 at Adriafer and 2.0 to 3.5 at Kraków – and quarterly EMS review meetings were established everywhere from a baseline of zero, institutionalising the "Check" and "Act" phases of the PDCA cycle and bringing maintenance, operations, procurement, IT and HSE functions into shared responsibility for environmental performance.

6.2. Weaknesses

As a first implementation cycle, the pilot action also identified the areas where the EMS packages will develop further along the continuous-improvement path that an environmental management system is designed to follow. These are the natural next steps that build on the foundation each partner has established and setting them out is one of the constructive purposes of the joint evaluation.



Table 6.3 - Areas for further development identified during the pilot action.

Area for development	Test sites	Next step
Consolidation of the most advanced procedures	DBV, Adriafer, Kraków, FBL	Move high-resolution gap and emission analysis from partly implemented to routine
Realization of the deferred economic returns	DBV, Kraków	Convert the monitoring foundation into measurable savings over the coming cycles
Consolidation of the transport-fuel trend	FBL	Expanding software functionality (e.g. forecasting)
Extension of emission coverage	Adriafer	Broaden from Scope 1 and 2 towards Scope 3 as capability matures
Engagement of tenant consumption	FBL	Build on monthly statements to influence the tenant-driven share - awareness raising, trainings
Growth of dedicated capacity	DBV, Kraków,	Widen the team as the EMS becomes embedded in routine operation

The procedures that require the highest data resolution are, understandably, the ones with most room to grow after a first cycle: high-frequency gap analysis and monthly emission analysis are already in place and functioning, scored as partly implemented, and the clear next step is to make them fully routine. DBV and Kraków invested first in instrumentation and measurement, which is the right sequence, and their economic returns are ahead of them rather than behind – DBV already shows a measurable EnPI improvement regardless the complexity of the open space environment, with the larger effect expected in the cooling season outside the testing window, while Kraków has built the monitoring architecture from which efficiency measures will follow. Alongside its strong results on heating and lighting, FBL identified that fleet gas oil and diesel consumption rose against the baseline (which is partly influenced by additional fuel consumption associated with travel by car to project pilot visits); the value of the pilot here is that the EMS made this trend visible for the first time, and FBL is now well placed to bring the indicator into line in the next phase by expanding software's functionality.

Adriafer's emissions accounting covers Scopes 1 and 2, and the partner has already planned the extension to Scope 3 as part of DORIS EMS; openly reporting the current boundary is a sign that the system is being used diagnostically. At the Freeport of Budapest, most energy consumption relates to tenant activities, and FBL has taken the first step by giving tenants visibility of their consumption through high-detail EMS software report statements – an opportunity now to develop this into a fuller engagement mechanism, a valuable lesson for the whole partnership since ports, airports, terminals and interchanges frequently share the same structure. At several sites, the EMS is operated by a small dedicated team, a sound starting point that widening involvement will further strengthen as the system becomes embedded; DBV also notes that its AI-compatibility upgrade was kept to a local installation in line with cybersecurity requirements – a sensible precaution and a useful piece of practical guidance for replication. The testing period of November 2025 to April 2026 covers six months and a single heating season, enough to demonstrate that the packages can be implemented and that monitoring works reliably, and it establishes the baseline for the longer horizon over which full annual cycles, the persistence of behavioural change and the returns on enabling investments will come into view. In this sense, the pilot is precisely what it was intended to be: a strong first step in a continuous-improvement process.

6.3. Transferability

The evidence supports a differentiated judgment on transferability: the components of the EMS packages are not equally portable, and distinguishing between them is essential for realistic replication planning.



Table 6.4 - Transferability of EMS package components based on the evidence of the four test sites.

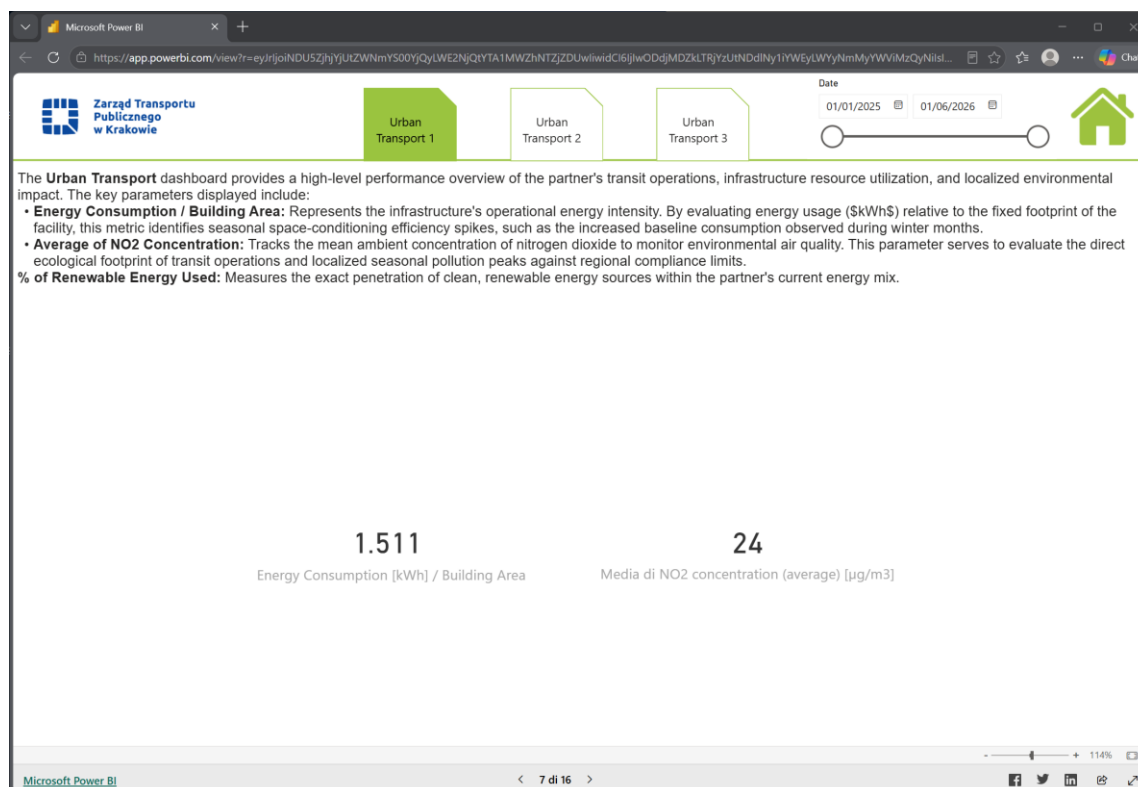
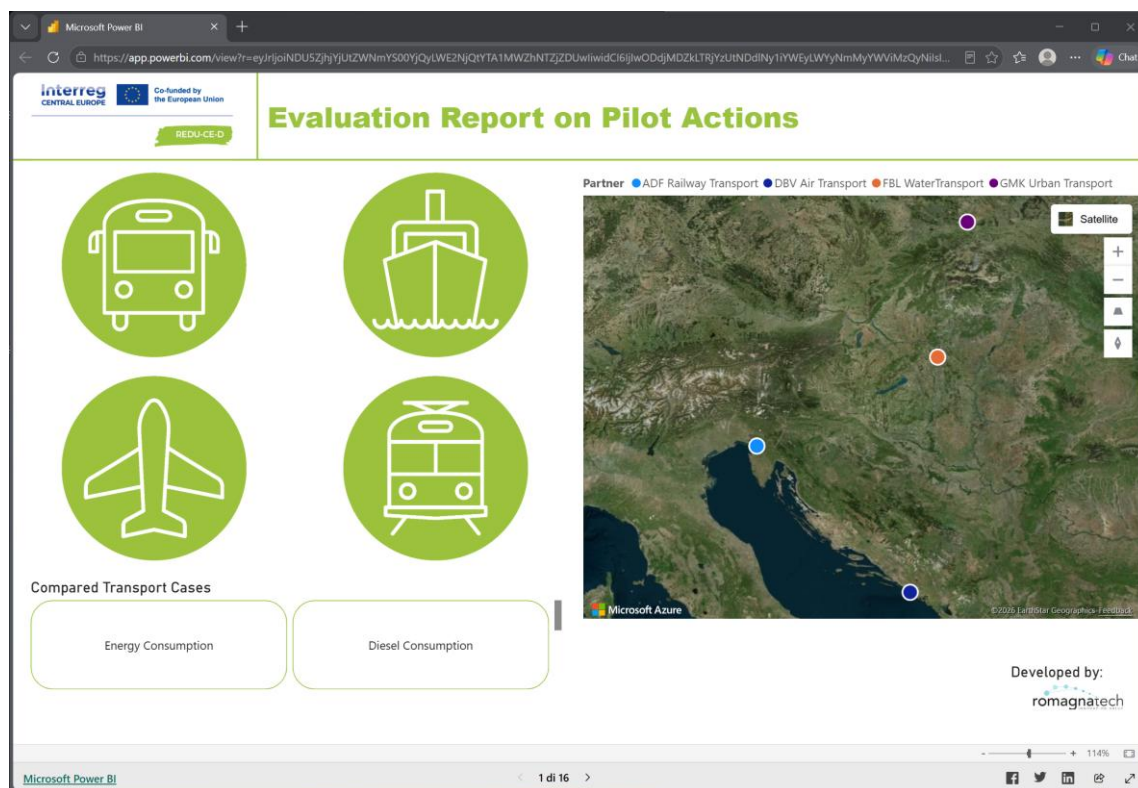
Component	Transferability	Basis in the evidence
Monitoring and data collection framework	High – mode-independent	Implemented successfully at all four test sites from very different baselines; common monthly templates and Power BI consolidation worked throughout
Procedures and review cycles (PDCA)	High – mode-independent	Procedures increased at all four sites; quarterly reviews were established everywhere from zero
Training and awareness modules	High – mode-independent	Introduced from a zero baseline at all four sites, with content tailored to each context
ISO 50001 implementation pathway	High for uncertified organizations	FBL implemented ISO 50001 during the testing phase without holding ISO 14001
Fuel-switching measures (e.g. HVO)	Medium – fleet-dependent	Adriafer results depend on a controlled fleet of six locomotives and on HVO availability and price
Facility-level smart-readiness upgrades	Medium – asset-dependent	Kraków SRI gains are tied to building systems and to the EU SRI methodology
Multi-tenant consumption management	Developing	FBL began with monthly statements for the tenant-driven share; a fuller mechanism is the next step

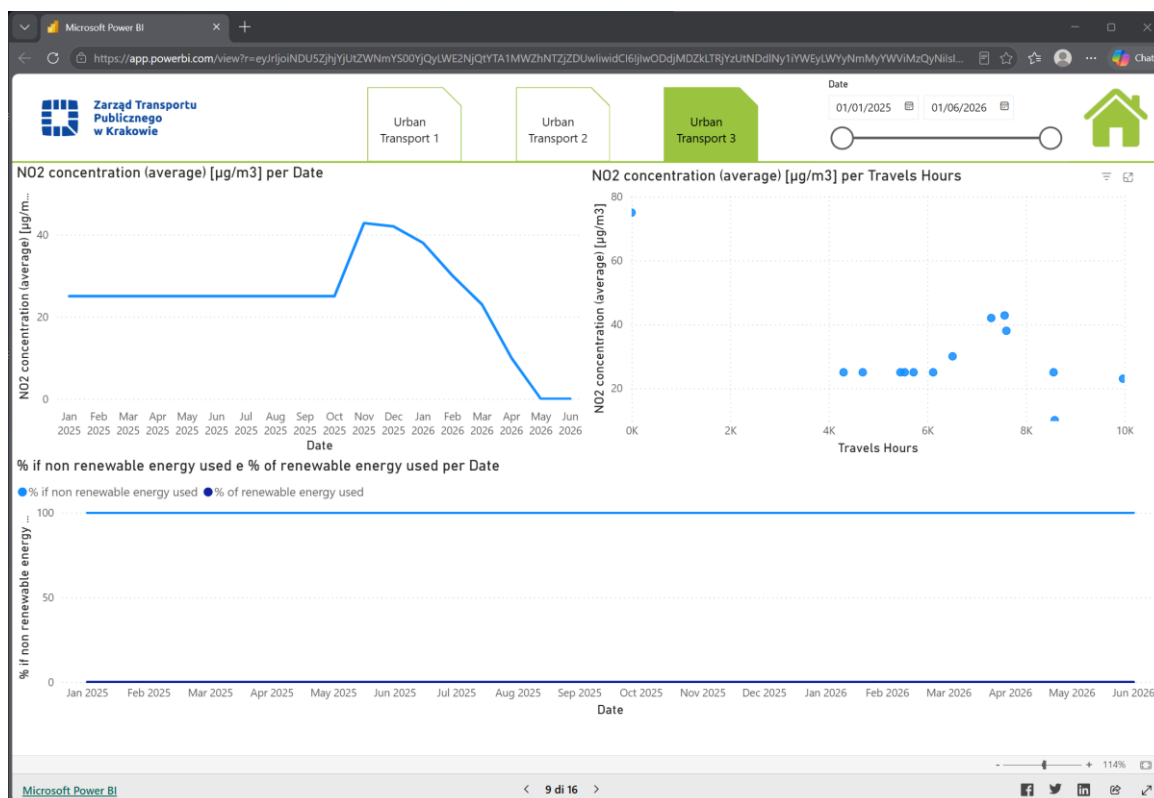
The most transferable proposition arising from the pilot action is therefore not a technology but a sequence: measure at adequate granularity, make the data visible to operational staff, institutionalise a review cycle, select interventions based on what the data reveals. This sequence proved valid in air, rail, waterway and urban contexts alike, and is applicable to organisations of very different sizes and certification maturity. A concrete example of transferability within the project is provided by project partner PPA (Port of Ploče), which, following the experience and results of the pilot action, decided to proceed with the implementation of an ISO-based management system. This represents an important project level outcome, demonstrating that the approaches tested through the pilot actions can stimulate their uptake and further implementation by other transport organisations.

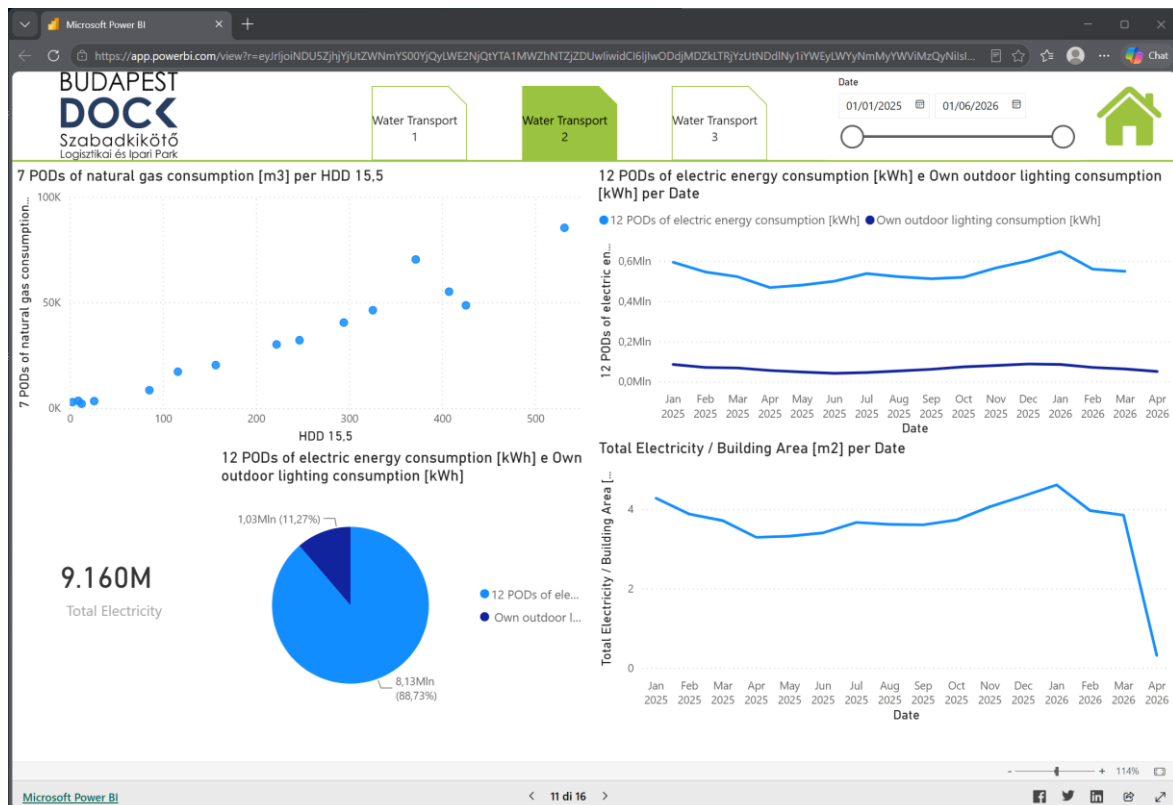
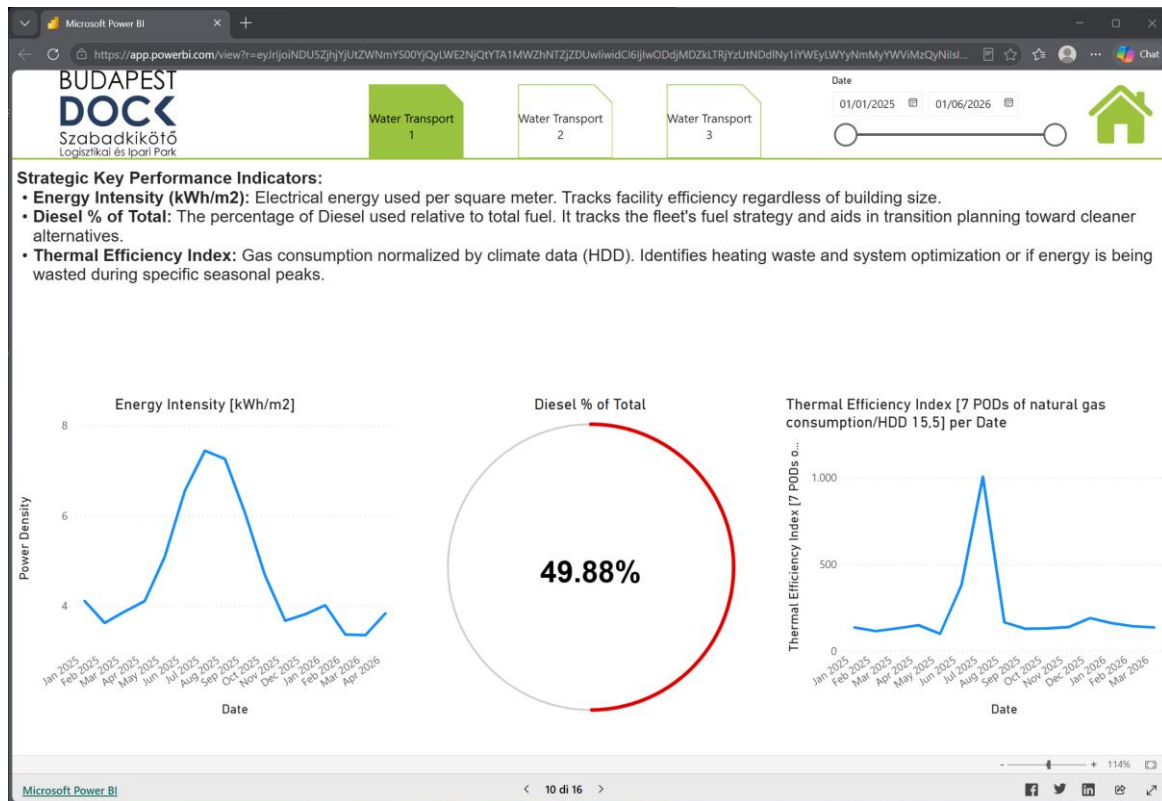


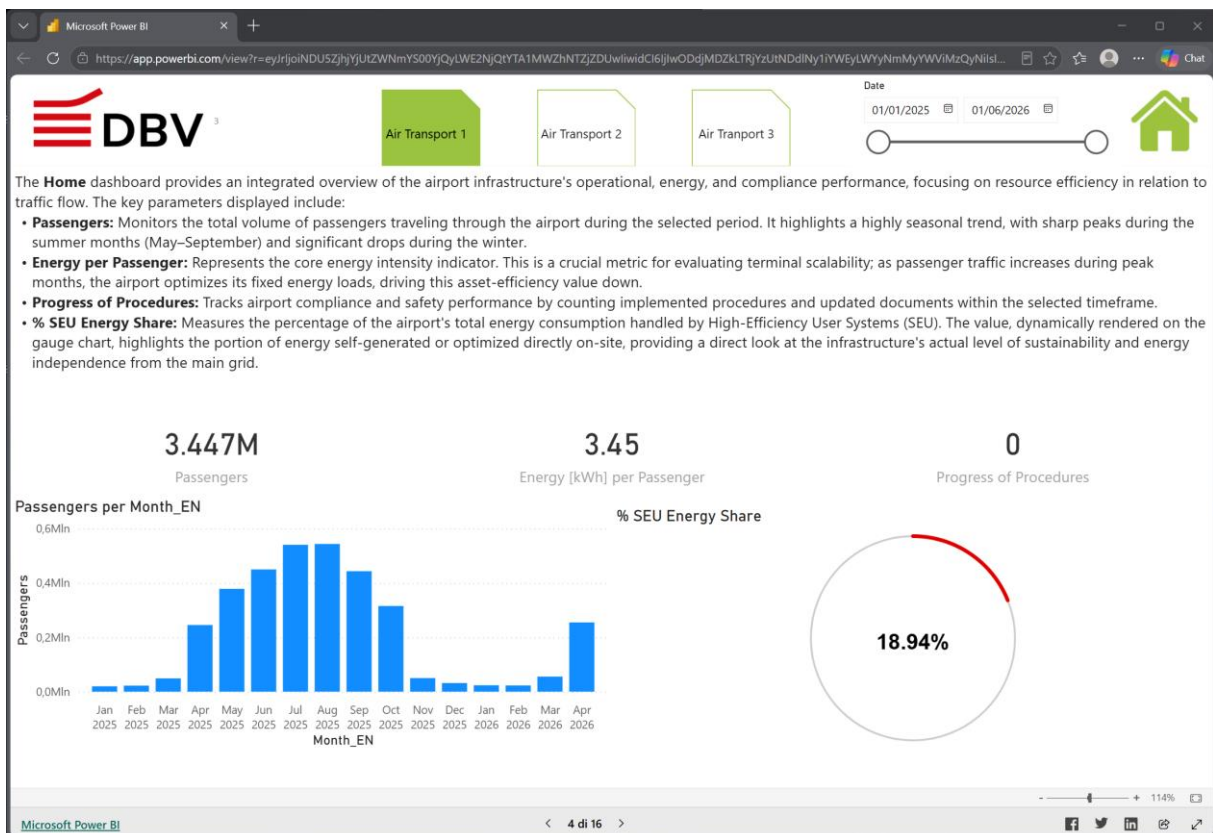
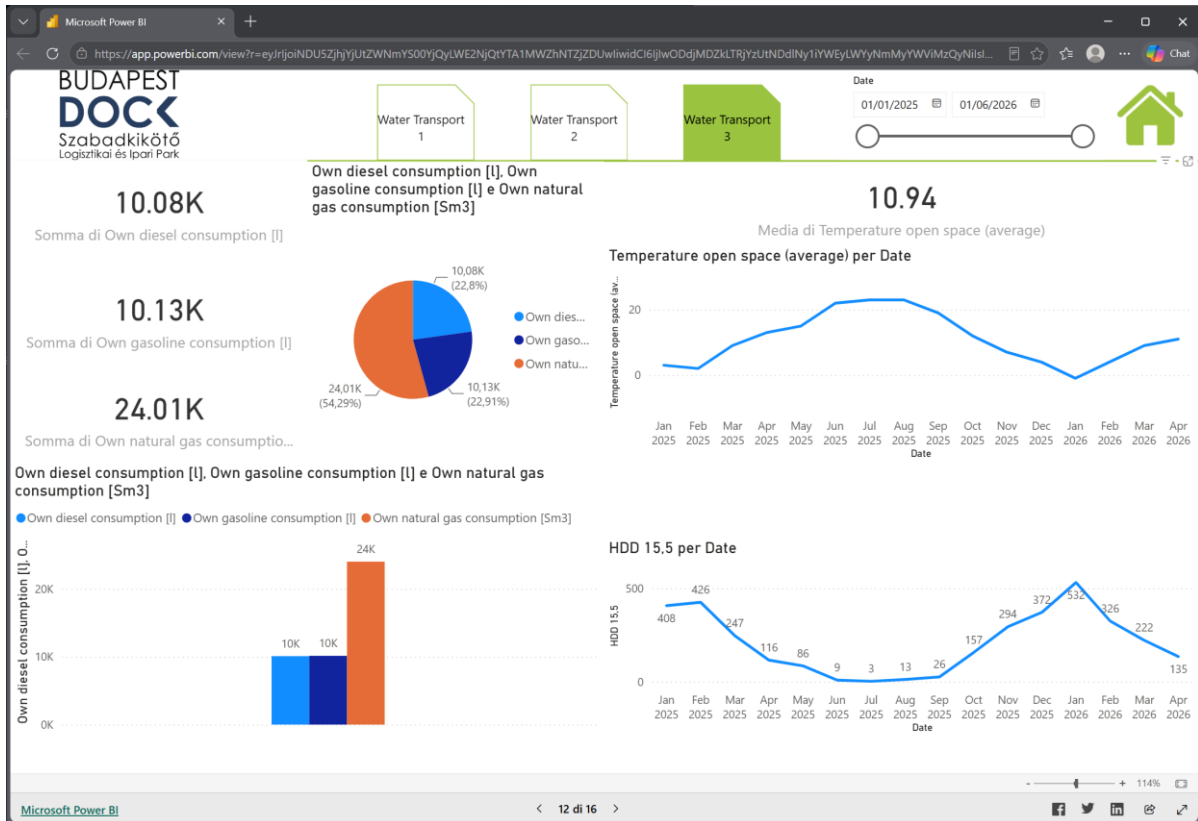
7. Annexes

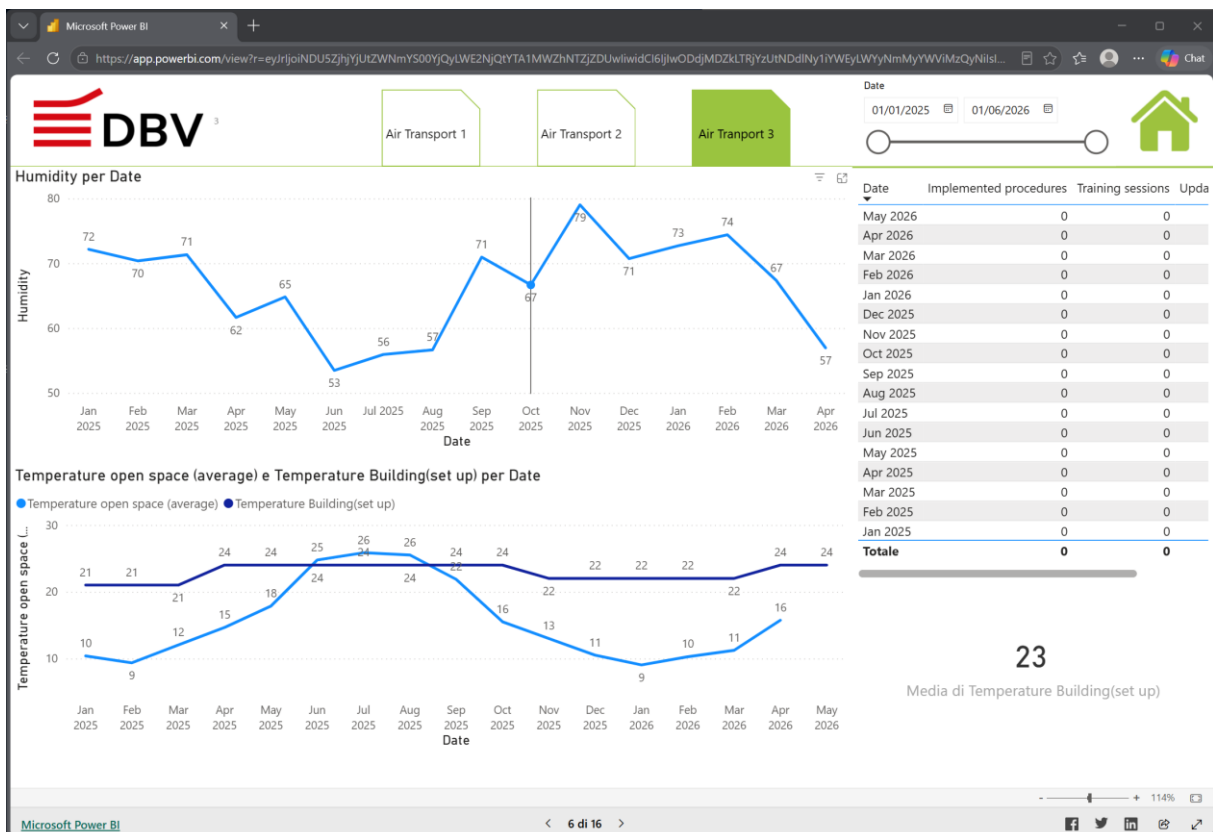
7.1. Dashboard screenshots

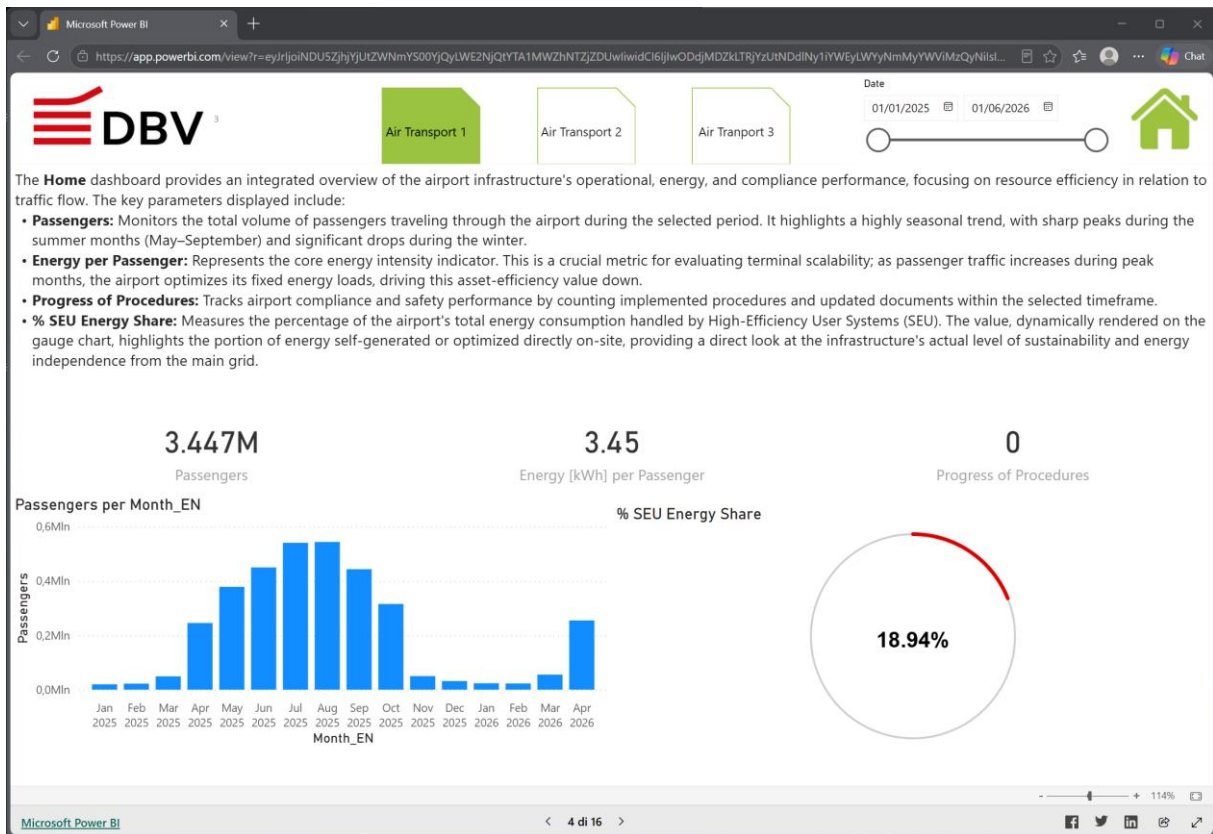


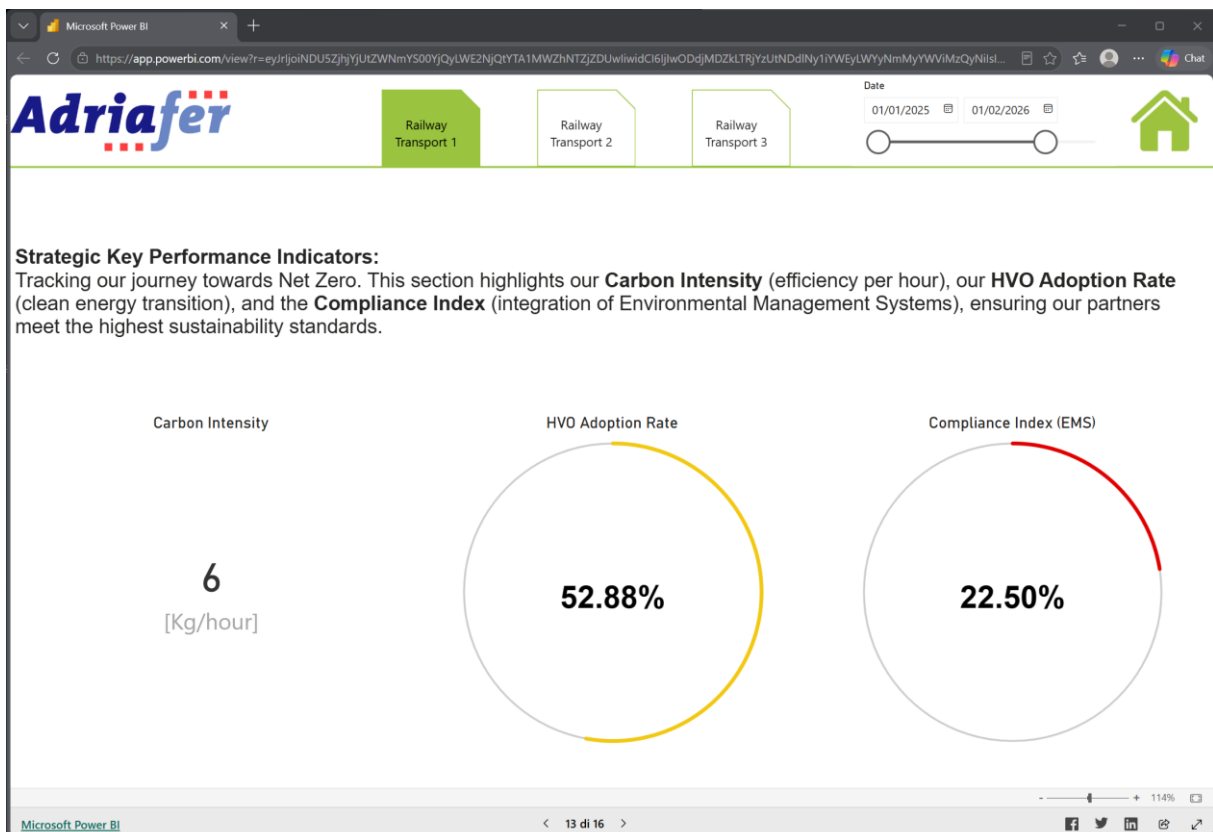
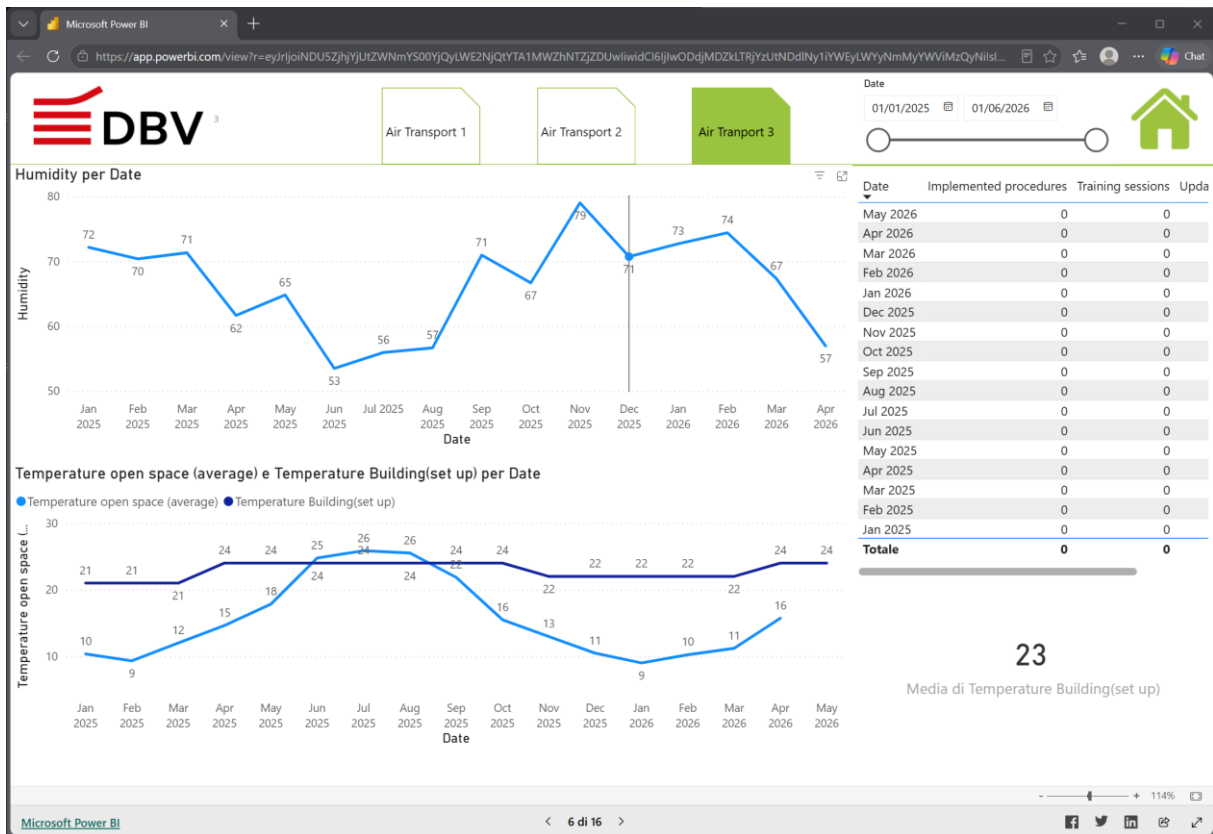


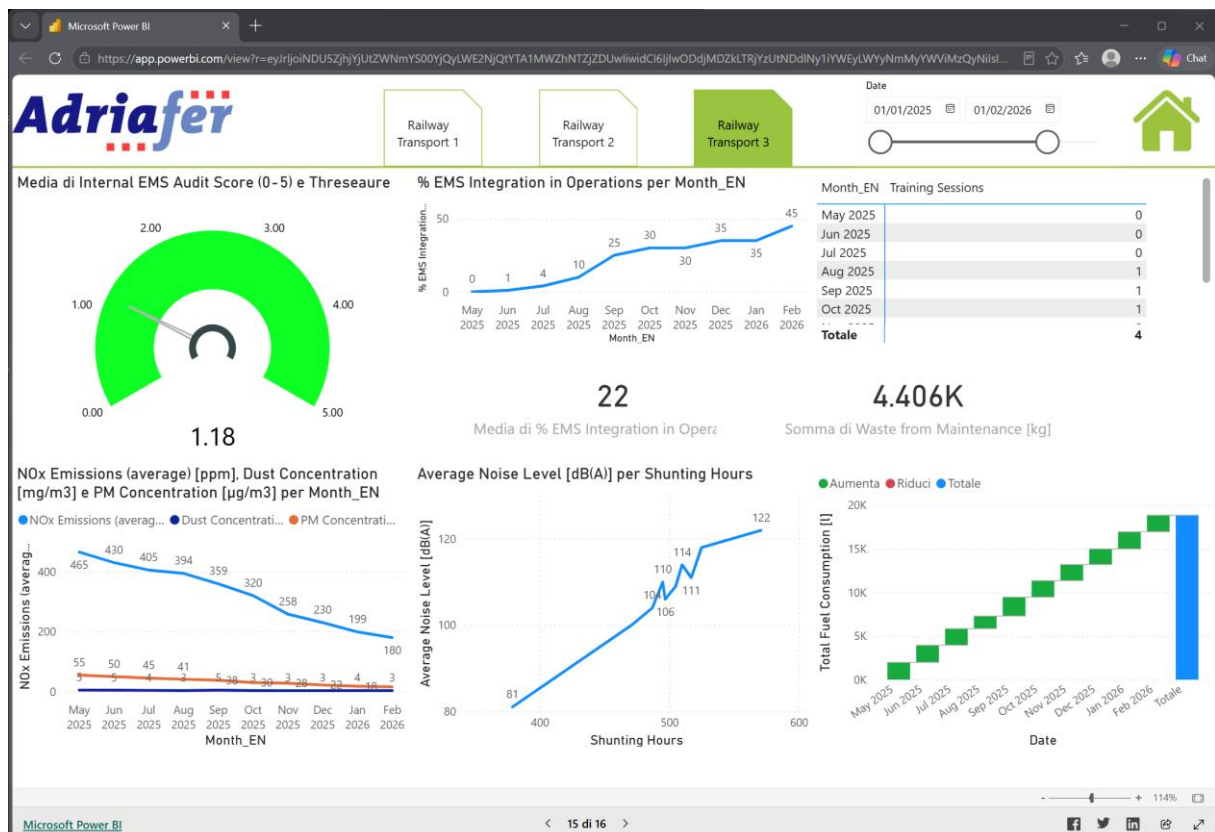
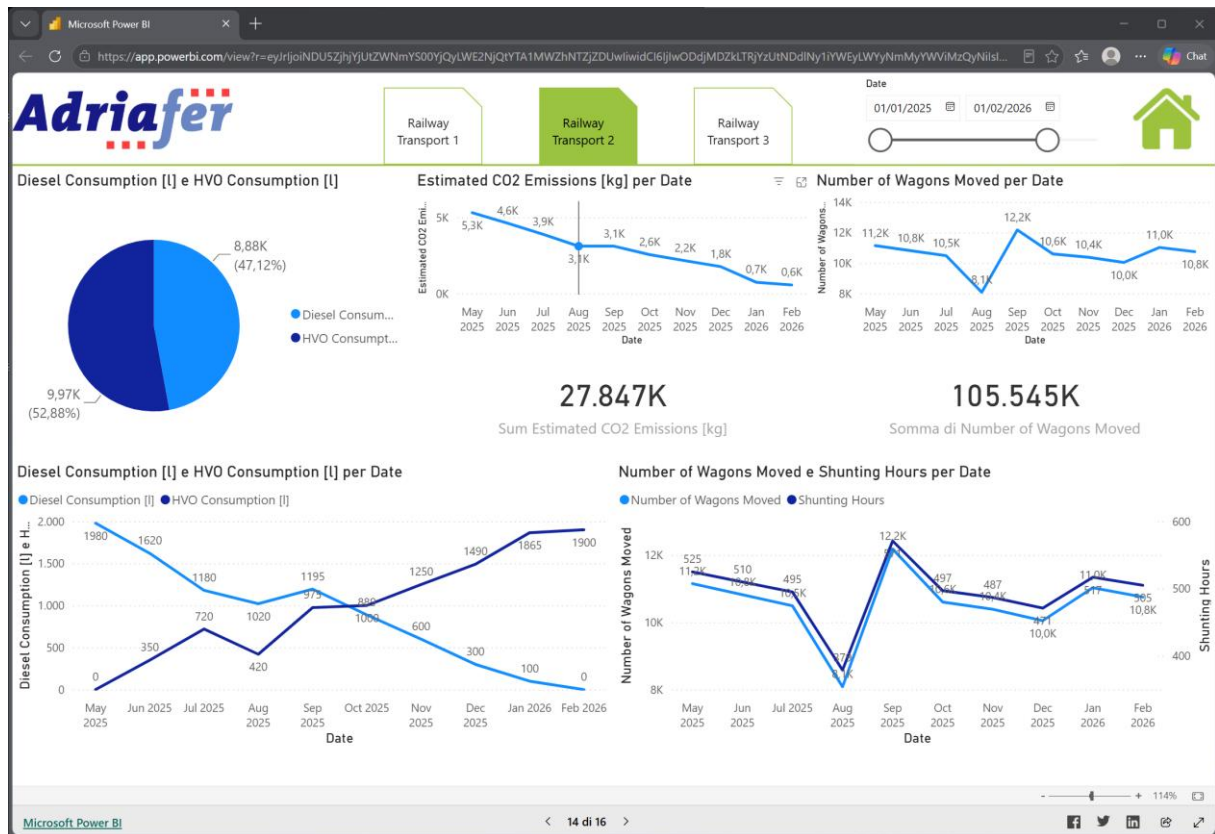














7.2. Power BI links

[Microsoft Power BI](#)

7.3. Monitoring data

ADF Railway Transport.xlsx - Google

https://docs.google.com/spreadsheets/d/18YuUKPsFZSjdDIWY0hsjFwIOAAmGiK8B/edit?gid=878727402#gid=87...

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Month	Year	Shunting Hours	Number of Wagons Moved	HVO Consumption [l]	Diesel Consumption [l]	Total Fuel Consumption [l]	Estimated CO2 Emissions [kg]	NOx Emissions (average) [ppm]	PM Concentration [µg/m3]	Average Noise Level [dB(A)]	Dust Concentration [mg/m3]	Waste from Maintenance [kg]	% EMS Integration in Operations	Implemented Procedures	Training Sessions	Internal EMS Audit Score (0-5)
2	5	2025	525	11150	0	1980	1980	5310	465	55	118	5,1	540	0	0	0	0
3	6	2025	510	10820	350	1620	1970	4620	430	50	114	4,7	525	1	0	0	0
4	7	2025	495	10490	720	1180	1900	3890	405	45	110	4,1	515	4	0	0	0,25
5	8	2025	379	8085	420	1020	1440	3112	394	41	81	3,46	502,36	10	0	1	0,5
6	9	2025	571	12181	975	1195	2170	3112	359	38	122	4,71	477,91	25	1	1	1
7	10	2025	497	10603	1000	889	1889	2557	320	30	106	3,43	435,27	30	1	1	1
8	11	2025	487	10389	1250	600	1850	2158	258	28	104	3,24	387,44	30	2	0	1,5
9	12	2025	471	10048	1490	300	1790	1772	230	22	100	3,19	366,32	35	2	0	2
10	1	2026	517	11029	1865	100	1965	746	199	18	111	3,51	337,11	35	3	0	2,5
11	2	2026	505	10750	1900	0	1900	570	180	16	109	3,4	320	45	3	1	3
12	3	2026	511	10896	1923	0	1923	577	182	16	110	3,44	323,88	55	4	2	3,25
13	4	2026	714	15204	2677	0	2677	806	254	23	149	4,81	447,49	55	4	1	3,45
14	5	2026	665	14164	2493	0	2493	751	237	21	138	4,48	415,52	60	4	2	3,6
15	6	2026	601	12801	2254	0	2254	679	214	19	124	4,05	384,14	70	5	1	3,9

Monthly Data

DBV Air Transport.xlsx - Google Sh

https://docs.google.com/spreadsheets/d/1b0J8f2C02RIH585bli37YqwsQOzLBGed/...

100% 123 Calibri 12 B I A

136

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Month	Year	Building Area [m2]	Total Energy Consumption [kWh]	SEU Energy Consumption [kWh]	Passengers	Temperature Building (set up)	Temperature open space (average)	Humidity	Implemented procedures	Updated documents	Training sessions	
2	1	2025	53,000.00	652,769.18	136,428.76	19,856.00	21.00	10.39	72.15	0.00	0.00	0.00	
3	2	2025	53,000.00	575,494.76	120,278.41	22,314.00	21.00	9.36	70.36	0.00	0.00	0.00	
4	3	2025	53,000.00	615,758.67	128,693.56	48,998.00	21.00	12.03	71.31	0.00	0.00	0.00	
5	4	2025	53,000.00	652,684.32	136,411.02	245,397.00	24.00	14.65	61.64	0.00	0.00	0.00	
6	5	2025	53,000.00	809,359.52	169,156.14	378,505.00	24.00	17.85	64.80	0.00	0.00	0.00	
7	6	2025	53,000.00	1,041,781.57	217,732.35	450,007.00	24.00	24.76	53.46	0.00	0.00	0.00	
8	7	2025	53,000.00	1,183,082.80	247,264.30	540,619.00	24.00	25.85	55.92	0.00	0.00	0.00	
9	8	2025	53,000.00	1,154,163.14	241,220.10	543,733.00	24.00	25.51	56.63	0.00	0.00	0.00	
10	9	2025	53,000.00	963,367.90	201,343.89	443,444.00	24.00	21.86	70.94	0.00	0.00	0.00	
11	10	2025	53,000.00	742,199.95	155,119.79	315,409.00	24.00	15.51	66.65	0.00	0.00	0.00	
12	11	2025	53,000.00	583,399.10	121,930.41	50,120.00	22.00	13.00	79.00	0.00	0.00	0.00	
13	12	2025	53,000.00	605,923.60	126,638.03	31,843.00	22.00	10.50	70.70	0.00	0.00	0.00	
14	1	2026	53,000.00	637,823.00	87,764.00	23,688.00	22.00	9.04	72.70	0.00	0.00	0.00	
15	2	2026	53,000.00	534,622.00	96,835.00	22,950.00	22.00	10.27	74.39	0.00	0.00	0.00	
16	3	2026	53,000.00	532,468.00	19,843.00	55,559.00	22.00	11.23	67.31	0.00	0.00	0.00	
17	4	2026	53,000.00	609,250.00	46,420.00	254,931.00	24.00	15.74	56.94	0.00	0.00	0.00	
18	5	2026	53,000.00	788,325.00	110,037.00	399,917.00	24.00	19.01	57.00	0.00	0.00	0.00	
19	6	2026	53,000.00	980,979.00	233,717.5	462,962.00	24.00	24.65	59.02	0.00	0.00	0.00	
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Monthly Data



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	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Month	Year	Building Area [m2]	HVAC Area [m2]	Own outdoor lighting consumption [kWh]	Own natural gas consumption [Sm3]	Own gasoline consumption [l]	Own diesel consumption [l]	12 PODs of electric energy consumption [kWh]	7 PODs of natural gas consumption [m3]	Temperature Building set up (average)	Temperature open space (average)	HDD 15,5
2	1	2025	158,962	63,508	85,092.15	3,954.60	482.27	547.34	594,612.00	55,117.54		3.0	407.5
3	2	2025	158,962	63,508	70,130.42	3,720.59	631.03	424.92	545,778.00	48,660.47		2.0	425.6
4	3	2025	158,962	63,508	67,543.64	1,477.05	597.97	594.78	522,255.00	32,118.67		9.0	246.8
5	4	2025	158,962	63,508	55,088.78	1,309.93	780.12	573.30	468,200.00	17,221.52		13.0	116.1
6	5	2025	158,962	63,508	47,280.55	776.87	706.59	757.26	480,487.00	8,454.12		15.0	85.5
7	6	2025	158,962	63,508	40,877.41	124.27	646.31	454.77	500,091.00	3,450.43		22.0	9.1
8	7	2025	158,962	63,508	44,773.48	97.16	820.83	622.90	537,949.00	2,815.26		23.0	2.8
9	8	2025	158,962	63,508	52,724.28	65.88	819.46	870.71	522,157.00	2,083.03		23.0	12.6
10	9	2025	158,962	63,508	60,837.18	166.82	256.08	942.73	512,198.00	3,333.74		19.0	26.2
11	10	2025	158,962	63,508	73,196.23	1,697.42	467.81	377.95	519,583.00	20,349.10		12.0	156.8
12	11	2025	158,962	63,508	79,679.08	2,402.50	528.44	816.66	566,155.00	40,473.93		7.0	294.4
13	12	2025	158,962	63,508	87,295.70	3,327.26	744.61	466.99	601,186.00	70,331.75		4.0	371.7
14	1	2026	158,962	63,508	85,092.00	3,311.19	519.25	518.38	647,841.00	85,290.90		-1.0	531.5
15	2	2026	158,962	63,508	70,130.42	2,244.11	880.65	759.22	559,977.00	46,316.97		4.0	325.6
16	3	2026	158,962	63,508	62,489.12	1,846.00	583.33	467.60	549,256.00	30,121.90		9.0	222.2
17	4	2026	158,962	63,508	50,049.19	743.00	666.23	888.86	466,434.00	16,803.80		11.0	134.7
18	5	2026	158,962	63,508	43,586.25	185.00	860.32	424.48	454,018.51	6,387.68		17.0	52.6
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Monthly Data

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	A	B	C	D	E	F	G	H	I
1	Month	Year	Building Area [m2]	Energy Consumption [kWh]	Water Consumption [m3]	Tickets	Travels, Hours of service (4-0)	% of renewable energy used	NO2 concentration (average) [µg/m3]
2	1	2025	14,038.33	35,501.00	133.00			0	25.00
3	2	2025	14,038.33	37,050.00	131.40			0	25.00
4	3	2025	14,038.33	21,550.00	140.50			0	25.00
5	4	2025	14,038.33	13,762.00	87.33	2,033	6,117	0	25.00
6	5	2025	14,038.33	10,755.00	90.20	1,733	5,540	0	25.00
7	6	2025	14,038.33	10,318.00	88.00	1,962	5,453	0	25.00
8	7	2025	14,038.33	10,810.00	89.00	1,855	4,689	0	25.00
9	8	2025	14,038.33	11,062.00	131.00	1,955	4,300	0	25.00
10	9	2025	14,038.33	11,347.00	132.00	2,316	5,720	0	25.00
11	10	2025	14,038.33	15,542.00	163.00	3,340	8,560	0	25.00
12	11	2025	14,038.33	26,609.00	56.00	2,449	7,567	0	42.80
13	12	2025	14,038.33	40,063.00	91.50	2,497	7,295	0	42.00
14	1	2026	14,038.33	56,766.00	86.00	2,582	7,602	0	38.00
15	2	2026	14,038.33	39,222.00	45.00	2,341	6,511	0	30.00
16	3	2026	14,038.33	24,153.00	40.00	3,530	9,969	0	23.00
17	4	2026	14,038.33	16,221.60	105.00	3,056	8,583	0	10.00
18	5	2026	14,038.33	12,781.76	120.00	5,647	8,807	0	10.00
19	6	2026	14,038.33	11,432.07	75.00	6,199	8,609	0	19.00
20	7	2026	14,038.33	10,244.00	70.00	3,539	7,082	0	0
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Monthly Data