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OPTI-UP

D.2.3.3 – Final solution for

better usage of alternative PT vehicles in the cities of Pécs and Český Krumlov

Version 3.0

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Abbreviations

AF	Application form
DRT	Demand-responsive transport
KPI	Key Performance Indicator
PT	Public transport

1. Background

1.1. About the thematic solution

The OPTI-UP project focuses on optimising public transport (PT) networks operation in small and medium-sized cities in Central Europe by integrating urban planning with data-driven approaches and promoting environmentally friendly mobility solutions. The approach was tested through three pilot projects, each addressing a specific thematic solution. Each thematic solution comprised two solution variants, implemented within a pilot action (PA) area:

- Demand-responsive transport (DRT): Modena (Italy) variant and Grosuplje (Slovenia) variant,
- PT network optimisation: Paks (Hungary) variant and Osijek (Croatia) variant,
- Alternative fuel technologies: Pécs (Hungary) variant and Český Krumlov (Czech Republic) variant.

The final thematic solutions consolidate knowledge and lessons learned from data-driven decision-making in PT planning, the implementation of pilot actions, and feedback obtained through user surveys and stakeholder consultations. These consultations provided valuable recommendations for improving the solutions, scaling them up, and ensuring their replicability in areas facing similar public transport challenges.

The overarching aim of each thematic solution is to provide decision-makers with a practical tool to support the selection, planning, and implementation of appropriate measures, thereby enabling the gradual improvement of public transport systems in selected areas.

This final solution specifically addresses the **alternative fuel solution**. It provides guidelines on how to transition from conventional buses to e-buses by optimising the allocation of alternative-fuel vehicles based on route demand and charging requirements. Its objective is to support the introduction of public transport services using alternative-fuel vehicles in order to make public transport more environmentally friendly, while maintaining transport efficiency, ensuring good vehicle utilisation, and ultimately stimulating transport demand through analytically grounded and interdependent service development.

1.2. Structure of the alternative fuel solution

The Alternative Fuels solution encompasses two distinct implementation variants: one carried out in Pécs (Hungary) and the other in Český Krumlov (Czech Republic). The final Alternative Fuels solution integrates both variants by:

- Presenting a comprehensive, generalised approach to the selection, planning, and implementation of alternative fuel buses, ensuring a cohesive (common) framework; and
- Incorporating the specific approaches and outcomes of each variant, with references to their implementations as documented in the OPTI-UP pilot action reports.

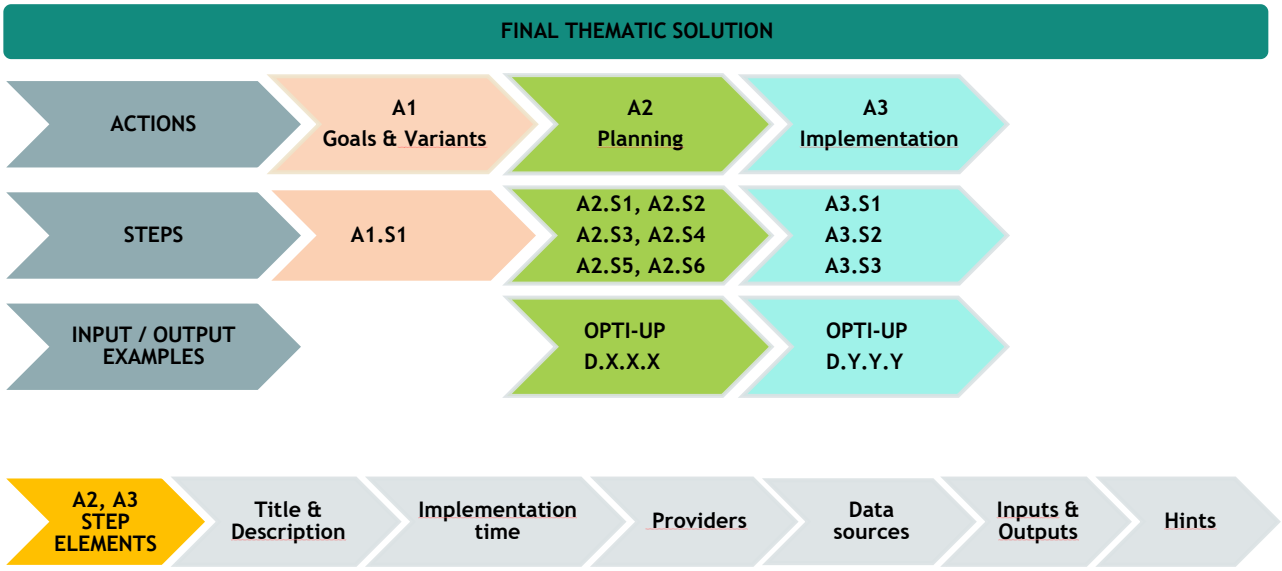
The alternative fuel solution is structured around three core actions: **A1**, **A2**, and **A3**.

Action **A1** serves as a baseline action that provides guidance on assessing whether the Alternative Fuels solution is relevant and beneficial for improving a specific public transport system. Step **A1.S1** defines the objectives of the Alternative Fuels solution, establishes decision-making criteria, and outlines the proposed approaches for implementing the different solution variants.

Actions **A2** and **A3** focus on the planning and implementation phases of the solution, respectively.

All three actions are divided into a series of sequential steps (e.g. A1.S1, A2.S1–A2.S6, and A3.S1–A3.S3). Each step provides practical guidance for carrying out specific activities within the respective action, enabling a step-by-step approach to selecting the solution, planning it (A2), and implementing it (A3).

Figure 1: Structure of final thematic solution



Each step within Actions A2 and A3 is described using a consistent set of key elements explained below:

- **Title & Description**: Describes the purpose of the step and the key activities involved (e.g. selecting a transport modelling tool, defining scenarios for solution simulation, conducting evaluations, or collecting target values).
- **Implementation Time**: Provides an indicative assessment of the duration of the step activity using qualitative categories such as short, medium, or long (e.g. a relatively long-term process compared to other steps).
- **Providers**: Identifies the entity responsible for carrying out the tasks (e.g. a public transport modelling expert) as well as the stakeholders involved in or contributing to the step (e.g. end users, consultants, authorities, unions, public transport operators, or public transport authorities).
- **Data Sources**: Lists potential sources of data, such as online databases, service providers, experts, equipment suppliers, national statistics offices, transport operators, or existing national or municipal transport models.
- **Inputs & Outputs**: Specifies the input data or external services required to perform the tasks (e.g. transport demand and supply data) and the expected outputs of the activity, such as documents, software or hardware tools (e.g. a transport modelling report, a transport model with scenario data, templates of terms of cooperation, or examples from pilot action areas provided in the appendix).
- **Hints & Tips**: Provides additional recommendations and lessons learned from the pilot actions (e.g. the importance of involving an experienced and reputable transport modeller to ensure efficiency and quality).

The identified **Inputs & Outputs** of each step may include references to documents that present concrete examples of the final Alternative Fuels solution implementation, as demonstrated in the OPTI-UP project pilot actions in Pécs (Hungary) and Český Krumlov (Czech Republic), respectively.

Descriptions of actions **A1**, **A2**, and **A3** are presented in the tables outlining the final solution, structured according to key step elements. Each step is linked to concrete examples of solution variants (Pécs or Český Krumlov), where applicable. These examples are documented in the OPTI UP project deliverables and are clearly referenced using the corresponding deliverable codes (e.g., D.2.1.3).

1.3. Outline of alternative fuel solution

The outline provides an overview of the actions and steps within the alternative fuel solution.

Action	Step
Action A1: Decision on the variant solution	Step A1.S1: Description of the goals, decision criteria, and main features of the solution
Action A2: Planning and fine-tuning of the alternative fuel solution	Step A2.S1: Collection of initial data
	Step A2.S2: Building a transport model
	Step A2.S3: Simulation of the solution through transport model scenarios
	Step A2.S4: Definition of the final solution for the selected area
	Step A2.S5: Definition of final solution implementation
	Step A2.S6: Definition of Key Performance Indicators
Action A3: Implementation of alternative fuel solution	Step A3.S1: Monitoring of the implemented final alternative fuel solution
	Step A3.S2: Evaluation of the implemented final alternative fuel solution
	Step A3.S3: Ensuring sustainability and planning the scaling up of the solution

2. Alternative fuel solution guidelines

2.1. A1: Selection of the variant solution

2.1.1. A1.S1: Description of the main features, goals and decision criteria

The OPTI-UP project provides two solution variants for improving the use of alternative-fuel public transport vehicles. One variant was implemented as a pilot action in **Pécs** (Hungary), and the other as a pilot action in **Český Krumlov** (Czech Republic).

The following table illustrates the main features of the setup and operation of the alternative fuel solution.

Table 1: Description of the main features of alternative fuel solution variants

Pécs	Český Krumlov
• Select an area that is not currently served by public transport • Plan a new route for the new line to be operated only with electric buses • Use exclusively electric buses to ensure an environmentally friendly service • Develop a timetable for the new line • Ensure that the service is attractive to passengers, based on user survey results • Promote the new bus service • Continuously monitor passenger volumes and track electric bus energy consumption • Analyze the collected data and conduct follow-up passenger satisfaction surveys	• Deployment of a fully electric bus operating on selected urban public transport routes to replace the conventional diesel bus. • Integration of zero-emission vehicles into the existing PT network. • Operation of electric buses under real operating conditions in a historic urban environment. • Overnight depot charging without daytime charging requirements. • Monitoring of vehicle performance, energy consumption and operational data. • Collection of passenger feedback and operational data for future network optimization. • Integration with regional public transport connections. • Promotion of sustainable and low-emission urban mobility. • Evaluation of data from the e-bus operation to establish a baseline, assess benefits, and determine the feasibility of further electrifying the city's public transport fleet.

The decision on which alternative fuel solution variant to apply can be made on the basis of the decision criteria listed below. The criteria are presented in order of priority, from highest to lowest.

Table 2: Goals of variant alternative fuel solution and decision criteria for its selection

Step element	Alternative fuel solution
Main goals	**Common goals:** - Obtaining reliable data to support further network optimization and potential route extensions. - Reducing CO_2 emissions and noise through the use of electric propulsion (significant emission reductions along the pilot route; improved air quality in the city centre) - Promoting the shift from individual car use to public transport **Specific goals:** **Pécs**: - Reducing operational costs of PT - Improve the accessibility and connectivity of local public transport **Český Krumlov**: - Increasing the availability and attractiveness of public transport in underserved areas - Ensuring accessible and inclusive transport for seniors and people with reduced mobility - Improving connectivity between peripheral areas and the city centre, including access to public amenities - Reducing parking demand and traffic congestion in the historic zone by increasing the attractiveness of public transport
Decision criteria for selection of the solution	**Common decision criteria:** - Need for gradual electrification of public transport **Specific decision criteria:** **Pécs**: - Enhancing connectivity of the new area by public transport - Suitability of the area for establishing new public transport lines and bus stops - Existence of corridors with high levels of car commuting to workplaces - High demand for connecting the area to the public transport network - Cost-ineffectiveness of operating conventional bus services - The PT network is already operated by diesel and electric buses **Český Krumlov**: - Low flexibility of existing bus routes - Outdated diesel-powered fleet causing environmental burden

	- Insufficient accessibility of the city centre for seniors and mobility-impaired residents - Congestion and parking shortage from private car traffic causing excessive emissions - Hilly terrain and historic urban environment requiring low-emission transport solutions - Need to test operational feasibility of electric buses in real conditions - Need for operational data for future fleet modernization

2.2. A2: Planning of alternative fuel solution

2.2.1. A2.S1: Collection of initial data

Activity/aim: This fundamental activity focuses on identifying and understanding the needs and observations of users, transport operators, or public transport authorities (PTAs) that have recognised public transport (PT) issues. The activity includes the systematic collection of relevant data, enabling thorough analyses to validate the identified issues and explore potential PT solutions. The data are collected for the following purposes:

- Spatial- demographic analysis,
- PT operation status,
- PT demand analysis,
- PT financial analysis,
- Transport modelling,
- Users' feedback analysis.

Table 3: Collection of initial data for variant solutions

Step element	Alternative fuel solution
Task provider	The transport expert collects data, performs analyses, prepares data reports, and develops a Local Plan for public transport development based on the analysis of input data.
Implementation time	Short - medium: 2-5 months
Involved Stakeholders	• Providers of data sources: PTA, PTO, Statistical offices, ministry of transport, municipality, citizens/PT users
Data sources	• National statistical offices, existing national, regional or municipality bodies (*national, regional or local transport models, transport plans, SUMP - also Integrated Urban Development Strategy of Pécs), online information*, transport operators (*transport operational data*), users' surveys, existing studies
Inputs	• Data collection model: - Spatial Demographic Data: ➢ Population trend (National statistical Office) ➢ Population structure by age and gender (National Statistical Office) ➢ Population density (National Statistical Office) - Public transport operational indicators: ➢ Fleet composition (PTO, municipality - Český Krumlov) ➢ Key operational statistics PT lines (PTO, PTA, municipality - Český Krumlov) - Public transport demand analysis: ➢ Demand trend in the past five years (PTO) ➢ Monthly demand (PTO)

	➢ Hourly demand (PTO) ➢ Derived demand statistics (PTO) - Public transport financial indicators: ➢ Cost and revenue trend ➢ Cost and revenue structure - Urban and spatial characteristics (**Český Krumlov**): ➢ Urban structure and land use characteristics ➢ Hilly terrain and topographical conditions ➢ Historic urban environment constraints ➢ Spatial distribution of residential and tourist areas ➢ Road network accessibility and capacity • Users' needs survey questionnaire: **Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.2.3; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.2.3
Outputs	• Presentation of data in a table of graphs (D.1.1.2_Unifed database of collected public transport systems, **Pécs**: worksheet "Pécs", **Český Krumlov**: worksheet "Český Krumlov") • Analysis of input data (D.1.1.1_ Comprehensive data report on existing public transport networks and best practices, find references to **Pécs** and **Český Krumlov** in the text) • Users' needs survey results: **Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.2.3; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.2.3 • Local plan - list of PT actions and KPI-s for monitoring and assessment of the implemented solutions, ch.5, ch.8, ch.9 (**Pécs**: D.1.3.1_Local Plan for the city of Pécs; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov)

Hints & tips: Taking into account user feedback on the current state of PT operations, as well as their suggestions for improvement and input on proposed solutions, is essential. This helps ensure greater acceptance of changes and reduces potential resistance to implementation.

User feedback in **Český Krumlov** highlighted insufficient frequency of public transport services, limited accessibility of peripheral areas and inadequate timetable coordination as the main weaknesses of the current public transport system. Respondents also suggested increasing the number of routes and departures, improving passenger information and enhancing the comfort and accessibility of public transport services. The survey confirmed the dominance of individual car transport and the need to increase the attractiveness and usability of public transport, especially considering the specific conditions of Český Krumlov, such as its historic city centre, hilly terrain and high tourist traffic.

2.2.2. A2.S2: Building a transport model

Activity/aim: The most efficient way to predict the impact of an applied alternative fuel solution in the observed PT area, to test the proposed KPIs, and to select the most relevant of them for evaluating the planned solution, is through transport modelling. This approach also provides insight into baseline and target values needed for KPI evaluation, particularly in cases where no historical KPI data are available.

The transport model can be fully developed in dedicated transport modelling software or supported by external mathematical models and descriptive statistics for the final interpretation of model results. Usually, a four-step transport model is used, consisting of the following modelling steps:

- Trip generation[1]
- Trip distribution[2]
- Mode choice[3]
- Route assignment[4].

If a transport model already exists, it should be updated with the most recent data and, where necessary, enhanced with additional features to ensure it serves as an accurate baseline model for the specific alternative fuel analysis.

Table 4: Building a transport model

Step element	Alternative fuel solution
Task provider	The transport expert develops or updates the transport model using the collected data and adds the specific features needed to model and evaluate the alternative fuel solution.
Implementation time	• Short: 2 months (if only minor transport model updates are needed) • Medium: 6 months (where extensive analyses, e.g. on-field surveys are needed) • Long: 12 months (for building transport model from scratch)
Involved Stakeholders	External transport model and data providers (transport experts, PTO) for communication and explanation of implementation of the existing transport model
Data sources	• For building and updating the transport model: - PTA (transport model, PT offer, transport coordination conditions, integrated timetable), - PTO (vehicle operational data, passenger demand, GTFS – transport network and timetable, emission data), - Municipality (SUMP – planned regional development, transport model, passenger demand) - National statistical office(population and demographic data for planning transport demand)

[1] How many trips originate and end in each transport model zone?
[2] Where are people travelling to and from?
[3] What transport mode do passengers chose for each trip?
[4] Which routes do travellers take, and what are the resulting traffic volumes on each transport network link?

	- Users' surveys and stakeholder consultations (public transport users' feedback and mobility behaviour data)
Inputs	• Transport and modelling and planning: - PTV VISUM (transport modelling software) - PTV Lines model - Existing transport model in VISUM: four-step travel demand model, providing PT data – PuT (OD matrix), bus and railway stops & network lines (shapefiles), zones, trips among zones (passenger demand and mobility), passenger estimation, vehicle types, vehicle emission data, vehicle operational costs, timetables, demography and spatial data etc.
Outputs	• Baseline transport model PTV VISUM and PTV Lines (**Pécs**) (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.5.2; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.4)

Hints & tips: The transport model for Český Krumlov is based on the VISUM transport modelling environment and uses local public transport operational data, demographic trends, passenger demand analysis and users' survey results. The baseline transport model was updated using recent operational and mobility data in order to evaluate short-term transport scenarios focused on public transport optimization, increased service attractiveness and the implementation of low-emission transport solutions.

2.2.3. A2.S3: Simulation of the solution through transport model scenarios

Activity/aim: To verify the expected impacts pursued by the implementation goals of the alternative fuel solution and to assess whether KPI targets can be achieved, implementation scenarios for the solution variant are created and simulated in the transport model (e.g. VISUM).

The modelled scenarios measure a change of selected KPIs (e.g. gas emissions, travelled kilometres, cost of operations (fuel), volume of passengers) from the baseline state to the state after the applied modelled scenario (solution) and meeting the set targets.

Table 5: Simulation of scenarios of implementation of the solution

Step element	Alternative fuel solution
Task provider	The transport expert defines and runs the scenarios, analyses the results, assesses KPI changes, and evaluates whether the targets have been achieved.
Implementation time	Short: 1 month
Involved Stakeholders	The PTO, PTA, and municipality support intermediate verification of the results, particularly in relation to observed anomalies.
Data sources	Baseline transport model implemented in the transport planning and traffic modelling software tool (**Pécs**: PTV VISUM, PTV Lines and **Český Krumlov**: PTV VISUM)
Inputs	• PTV VISUM transport modelling tool • PTV Lines modelling tool • Baseline transport model PTV VISUM and PTV Lines (**Pécs**) (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.5.2; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.4) • Proposed scenarios: (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.5.3, ch.5.4; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.5)
Outputs	• Results of transport model scenarios (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.5.3, ch.5.4; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.5)

Hints & tips: If the transport model used, as in the case of VISUM, does not provide a straightforward tool for simulating an alternative fuel solution, one or more proxy scenarios should be developed to partially emulate the expected impacts of the applied solution.

Scenario simulations for **Český Krumlov** have compared the baseline transport model with proposed transport measures in order to evaluate their impacts on passenger flows, operational efficiency, emissions and modal split. The transport model can be used to test scenarios focused on increasing service frequency, public transport optimization and the implementation of low-emission vehicles, taking into account the specific conditions of Český Krumlov, such as the historic city centre, tourist traffic and accessibility of peripheral areas.

2.2.4. A2.S4: Definition of the final solution for the selected area

Activity/aim: Based on the initial analyses, including spatial-demographic data, public transport (PT) operational indicators, PT demand patterns, financial performance, and transport modelling results, the proposed alternative fuel solution is comprehensively defined and adapted to the specific characteristics of the intervention area.

The final solution is developed to align with established transport goals and expected outcomes, while ensuring consistency with the priorities of decision-makers and funders, the availability of resources, the operational capacities of service providers, and existing monitoring and evaluation capabilities.

The final solution is detailed in the **Final Solution Implementation Plan**, which outlines the service design, deployment strategy, and performance monitoring framework.

Table 6: Fine-tuning of the final solution

Step element	Alternative fuel solution
Task provider	A team of transport experts conducts final analyses, proposes and fine-tunes the final solution, and cooperates with the involved stakeholders.
Implementation time	Short: 3 months
Involved Stakeholders	• For discussion on the conditions of the solution to be feasible and acceptable: - Municipality where the solution will be implemented - PTA - organisation of PT in the observed area - PTO - providing experience, on-field knowledge and operational data - Citizens and PT users (advisable)
Data sources	• Results of previous research and planning (desktop analyses, transport modelling, local plan) • Consultation meetings with the involved stakeholders • Results of the survey on PT users' needs (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.2.3; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.2.3)
Inputs	• Results of transport modelling (demand analysis, mobility gaps), requirements of local communities, decision makers (strategic objectives), experience and knowledge of the operators - operational data (update on timetables, vehicles, costs of operation), proposed measures • Results of transport model scenarios (including environmental and operational indicator) (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.5.3, ch.5.4; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.5)
Outputs	• Description of alternative fuel solution and expected impacts - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.1 & 2.2, **Český Krumlov**: ch.3.1 & 3.2)

Hints & tips: Prior to the implementation of the final solution, a Final Solution Implementation Plan is developed. This plan comprehensively outlines all required activities, allocates resources, identifies key stakeholders, assesses potential risks, and establishes a monitoring framework. A clear and detailed definition of the final solution is essential to enable an effective assessment of the system's performance and operational efficiency once implemented. It also provides a solid foundation for defining relevant Key Performance Indicators (KPIs) and setting realistic target values, as well as for systematically monitoring progress toward achieving these targets.

2.2.5. A2.S5: Definition of final solution implementation

Activity/aim: For the **implementation** of the final solution, all activities must be clearly defined, covering the entire process from planning, user communication, securing resources, permits, and funding, through deployment, to monitoring, evaluation, and promotion of results to users and stakeholders.

The activities should be systematically organised within a detailed time plan, as presented in the **Final Solution Implementation Plan**. The plan should also include stakeholder engagement, identify relevant actors and their roles, and assess potential risks associated with delivering the solution, together with appropriate mitigation measures.

Table 6: Definition of implementation phases for the final solution

Step element	**Alternative fuel solution**
Task provider	The transport solution project manager proposes the implementation phases and discusses stakeholder engagement and implementation risks with the relevant stakeholders.
Implementation time	Short: 2 months
Involved Stakeholders	• For revision and feedback on the alternative fuel implementation plan: - Municipality - PTA (trigonal public transport authority) - PTO (definition of operational resources, capacities and operational procedures) - Transport expert (transport analytics) - Citizens and public transport users
Data sources	• Consultation meetings with the involved stakeholders on the basis of previous analytics and modelling
Inputs	• Revision and suggestions underpinned by former analytics and data (PT operational data, ridership, financial data, user surveys and feedback, PT routes, timetables, available fleet and staff etc.), knowledge of operational and formal procedures and capacities of operators
Outputs	• Final Solution Implementation Plan - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.1 & 2.2 & 2.3, **Český Krumlov**: ch.3.1 & 3.2 & 3.3) • Plan of stakeholders' engagement - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.2.2; **Český Krumlov**: ch.3.2.2) • Assessment of risks - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.2.3; **Český Krumlov**: ch.3.2.3)

Hints & tips: Effective coordination of activities is essential for the successful implementation of the final solution. While it may be time-consuming in the initial stages, it significantly reduces the risk of failures and negative external influences, ultimately improving efficiency and saving time in later phases.

2.2.6. A2.S6: Definition of Key Performance Indicators

Activity/aim: Monitoring the implementation of a solution is crucial, and Key Performance Indicators (KPIs) are essential tools for assessing the performance of the solution.

Systematic monitoring allows for:

- tracking the progress of implemented activities, enabling fine-tuning of the solution, adjustment of operational deviations, and response to feedback from users and operators; and
- conducting regular, real-time assessments of performance against predefined target values expressed through the KPIs.

The definition of KPIs, along with the associated monitoring tools and data sources, is provided in the **Final Solution Implementation Plan** and used in the monitoring report.

Table 7: Definition of Key Performance Indicators for the final alternative fuel solution

Step element	Alternative fuel solution
Task provider	The transport solution project manager, in cooperation with the transport expert, defines KPIs for monitoring the performance of the alternative fuel solution.
Implementation time	Short: 1 month
Involved Stakeholders	• Transport expert closely cooperates with the project manager (=transport solution operational manager) • Operational data providers (PTO,…)
Data sources	• Own previous analyses, modelling and reports • List of available input data for calculation of KPIs (passenger counts, timetables, km, costs)
Inputs	• Knowledge on standardized values entering definitions of KPIs • Users' survey needs feedback - **Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.2.3; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.2.3 • Results of transport model scenarios (**Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch. 5.3, ch.5.4; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.6.5) • Expertise on KPIs from transport expert (interpretation of analytics and modelling & definition of baseline and target values) • List of available KPIs: **Pécs**: D.1.3.1_Local Plan for the city of Pécs, ch.8; **Český Krumlov**: D.1.3.1_Local Plan for the city of Český Krumlov, ch.9

Outputs	• List of applied KPIs (definition, data sources, baseline and target values) – D.2.2.1_Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.3.2.5, **Český Krumlov**: ch.3.2.6): name, input data, calculation formula, data source, KPI calculation tool

Hints & tips: The time required to define KPIs may be extended if the necessary input data are not available, which may require a more complex approach to KPI calculation. A Monitoring Tool should be developed before the monitoring process begins. The tool should support periodic real-time monitoring, which is crucial for responding promptly to the needs of users and operators, managing deviations from expected solution performance, and improving overall performance.

2.3. A3: Implementation of alternative fuel solution

2.3.1. A3.S1: Monitoring of the implemented alternative fuel solution

Activity/aim: Monitoring the implementation and performance of the alternative fuel solution begins when the service starts operating. It is supported by a dedicated Monitoring Tool, which enables the collection of operational and other input data, as well as the periodic calculation of KPIs.

For **implementation** monitoring, the Monitoring Tool provides detailed information on when and how each implementation activity has been carried out.

For **performance** monitoring of the alternative fuel solution, the Monitoring Tool supports the collection of relevant operational data, such as date and time of departure, number of passengers, type of vehicle used, commendations and complaints. It also enables the continuous calculation of KPIs on a regular basis (e.g. weekly).

Table 8: Monitoring of the implemented alternative fuel solution

Step element	Alternative fuel solution
Task provider	The transport expert collects data from the PTO or PTA, keeps records, pre-processes the data to fit the Monitoring Tool where needed, and performs real-time monitoring of implementation and performance.
Implementation time	Duration of the monitoring period (e.g. during pilot activity or long-term…)
Involved Stakeholders	• Providers of the operational data (PTO, PTA) • Municipality (input data on promotion) • Users (providing feedback)
Data sources	• Connection to the database server related to monitoring app, spreadsheet (via e-mail) by PTO – containing KPI input data (operational data, passengers) • Municipality (implementation progress and local feedback) • Users (feedback)
Inputs	• Final Solution Implementation Plan - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.1 & 2.2 & 2.3, **Český Krumlov**: ch.3.1 & 3.2 & 3.3) • Users' feedback questionnaire (implemented online or in person) – available in D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.3, **Český Krumlov**: ch.F.3) • Empty "Performance monitoring tool" for input data collection and calculation model for calculation of KPIs from the operational data (Excel spreadsheet)

Outputs	• Final solution implementation monitoring tool (filled in) - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.3, **Český Krumlov**: ch.3.3) • Users' feedback survey – collected data, stored in the spreadsheet for analysis • Calculated KPI-values on the weekly basis: in the "Performance monitoring tool" (Excel spreadsheet), stored for analysis

Hints & tips: For additional information in the implementation monitoring table, add a separate column with explanations of specific activities, including references to external materials, photos, or web sources. This will make subsequent reviews and reporting easier and more transparent.

2.3.2. A3.S2: Evaluation of the implemented alternative fuel solution

Activity/aim: The evaluation of the implementation and performance of the alternative fuel solution, including the final conclusions, is carried out through the analysis of monitoring results and the incorporation of stakeholder feedback and recommendations on the implementation.

The evaluation of the solution **implementation** provides a report on how and when the activities were carried out. More importantly, it identifies implementation difficulties, deviations, and mitigation measures, resulting in a final **SWOT analysis** of the implementation process.

The evaluation of solution **performance** presents weekly trends in KPI changes compared to the baseline values and assesses the achievement of target values during the observation period. Based on the KPI analysis, an overall assessment of the alternative fuel solution is provided.

Table 9: Evaluation of the implemented alternative fuel solution

Step element	Alternative fuel solution
Task provider	The transport expert provides analyses, evaluations, and reporting on implemented activities and KPI monitoring, and cooperates with the **project manager** in conducting stakeholder consultations. Together, they prepare the conclusions.
Implementation time	Short: 1 months after conclusion of monitoring
Involved Stakeholders	• PTO, Municipality, PTA, passengers (for presentation of the results and getting feedback)
Data sources	• Collected data through monitoring of implementation and monitoring by using "Monitoring tools" and users' survey database (Excel, …)
Inputs	• Final solution implementation monitoring tool (filled in) - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.3, **Český Krumlov**: ch.3.3) • Users' feedback survey – collected data, stored in the spreadsheet for analysis • Calculated KPI-values on the weekly basis: in the "Performance monitoring tool" (Excel spreadsheet), stored for analysis
Outputs	• Implementation monitoring **report**: - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.3, **Český Krumlov**: ch.3.3) • Difficulties and deviations from the plan - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.4, **Český Krumlov**: ch.3.4) • SWOT analysis of implementation - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.5, **Český Krumlov**: ch.3.5)

	• Evaluation of performance – KPIs: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.2, **Český Krumlov**: ch.F.2) • Evaluation of users' feedback: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.3, **Český Krumlov**: ch.F.3) • Comprehensive conclusions on implementation and performance of alternative fuel solution – D.2.2.1 – Comprehensive evaluation report and recommendations for thematic solutions scaling up (common SWOT analysis: ch.6.1.3; key results and reached expectations: **Pécs**: ch.6.2.1.5, **Český Krumlov**: ch.6.2.1.6; key common outcomes: ch.6.2.2.3)

Hints & tips: The evaluation report may also include a dedicated section providing guidance on scaling up the applied solution and transferring it to other contexts. It may also include a roadmap for maintaining and further developing the implemented solution.

2.3.3. A3.S3: Ensuring sustainability and planning of scaling up of the solution

Activity/aim: Planning improvements and scaling up the implemented alternative fuel solution is a direct response to implementation and performance monitoring. Its aim is to improve efficiency and sustainability, while also supporting the **scalability** and **transferability** of the solution. This process involves meeting financial, operational, and institutional conditions, as well as providing recommendations **for ensuring the long-term sustainability** of the solution and it's **scaling up** through further development. Scaling up may also include transferring the solution to other areas, particularly neighbouring municipalities and regions facing similar public transport challenges.

Evaluation of implementation results is a prerequisite for planning modifications to the alternative fuel solution. The resulting plan should provide clear guidance for future actions to ensure sustainability, specifying the measures to be implemented, the responsible providers, and the required resources.

Continuous performance monitoring of the implemented alternative fuel solution provides essential input for improvements, upscaling, and replication. Plans for sustainability and scaling up should be developed in cooperation with relevant stakeholders, in order to incorporate practical insights into financial, operational, and organisational (institutional) conditions, as well as the available options for further development.

Table 11: Planning the scaling up of the solution

Step element	Alternative fuel solution
Task provider	The transport expert and project manager prepare conclusions from the implementation and performance analysis as input for stakeholder discussions, gather feedback on recommendations for scaling up and replicability, and prepare the report.
Implementation time	Short: 2 months (preparation of the discussion and reporting)
Involved Stakeholders	• Included in consultation process: - PTA (transport authority, infrastructure provider, formal procedures), - PTO (definition of operational resources, capacities and operational procedures), - Municipality (location of implementation of the solution and PT co-financer)
Data sources	• Results of own evaluation of the implemented solution (monitoring)
Inputs	• Implementation monitoring **report**: - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.3, **Český Krumlov**: ch.3.3) • Difficulties and deviations from the plan - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.4, **Český Krumlov**: ch.3.4) • SWOT analysis of implementation - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.5, **Český Krumlov**: ch.3.5) • Evaluation of performance – KPIs: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.2, **Český Krumlov**: ch.F.2)

	• Evaluation of users' feedback: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.3, **Český Krumlov**: ch.F.3) • Presentation and questions for the stakeholders' consultation
Outputs	• Guidance for future actions for sustainability - D.2.1.3 Pilot action report Pécs and Český Krumlov project areas (**Pécs**: ch.2.7, **Český Krumlov**: ch.3.7) • Consultation of stakeholders: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Pécs**: ch.E.4.3, **Český Krumlov**: ch.F.4.3) • Common lessons learned and suggestions for replicability (measures, responsibilities, recommendations) - D.2.2.1 – Comprehensive evaluation report and recommendations for thematic solutions scaling up, ch.6.3

Hints & tips: The involvement of stakeholders already identified during the planning phase is crucial for ensuring the sustainability of the implemented solution and its potential for scaling up or replication. Stakeholders contribute diverse perspectives and help secure the necessary conditions for institutional support, financial and operational viability, and acceptance by end users.