Best practices for H2O management and savings for BUS operators

H2OBUS

D5.3 Extract of the project data from the

LIFE KPI webtool

[Final Version January 31st, 2026]

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List of abbreviations

Abbreviation	Long Version
CBA	Cost-Benefit Analysis
DQ	Design Question
DoW	Description of Work
KPI	Key Performance Indicators
LPI	Life Webtool indicators
LUCs	LIFEH2OBUS Case Studies
WP	Work Package

1. PROJECT DESCRIPTION

1.1 Context and overall objectives

LIFEH2OBUS builds for the first time a European best practice on water management for bus transport operators to reach the lowest possible water consumption; the best practice has been demonstrated during the project, supported by an innovative software system and proved to be flexible enough to adapt to different economic and geographical/climate contexts, to be shared and adopted as widely as possible. This is the first time a major public transportation project focuses on water management, which has been a neglected and underestimated topic in this sector for far too long in favour of alternatives mobility power sources considering that about 43 million m^3 of fresh water are consumed per year in Europe to clean buses, as estimated in the Description of Work (DoW) document. The idea was that of applying three different state-of-the-art solutions, namely: (i) simple wastewater reclamation; (ii) wastewater reclamation in combination with rainwater harvesting system; and (iii) external waxing without water and compare them at three different European locations (at Arriva depots), specifically in Italy, Croatia and Hungary. For one-year demonstration, main parameters have been gathered and monitored by means of the Intelligent Garage Management system, that was customized and implemented by Pluservice. Operational, environmental, climatic and economic data have been analysed and evaluated by University La Sapienza to provide a final matrix between location and techniques with a score of efficiency, pros and cons of their application and costs, accompanied by technical guidelines (these in WP6). The average project water saving that LIFEH2OBUS can bring was initially calculated as - 84% water consumption for fleet washing. LIFEH2OBUS will contribute to push the transport sector towards its sustainability and circularity, while providing the community with guidelines.

1.2 Workplan

The LIFEH2OBUS consortium has initially developed and structured a 42-month workplan for the successful design, deployment/operation, performance evaluation and validation as best practices of the technologies implemented through the project. The LIFEH2OBUS workplan is divided into seven work packages, the Gantt chart of the project is included therein.

The structure of the LIFEH2OBUS work plan strategy (Figure 1), which guarantees a solid concatenation of activities to unfold optimal results, foresees the three major following phases:

- Requirements, set-up and initialization phase (12 months duration): WP2 “Set-up” and WP3 “Technology Installation”, involves the following activities: (i) definition, design and perfectioning of technology requirements and P&IDs for all the Arriva’s depots included in the LIFEH2OBUS project; (ii) drafting of technical and administrative documents to start up and go through the procurement process, which comprehends provider choices for quotation and negotiation phase; (iii) undertake the legal and bureaucratic duties to collect the building and installation permits and preparing the construction sites areas and logistics to accommodate the technology supplies; (iv) design of the novel predictive maintenance algorithm and testing; and (v) start and finalize the installation of the novel solution, with all the various specifics, and conclude the phase with the preparation of the fleet to pave the way for the implementation phase to start. These include the first washing and waxing of the defined fleets.

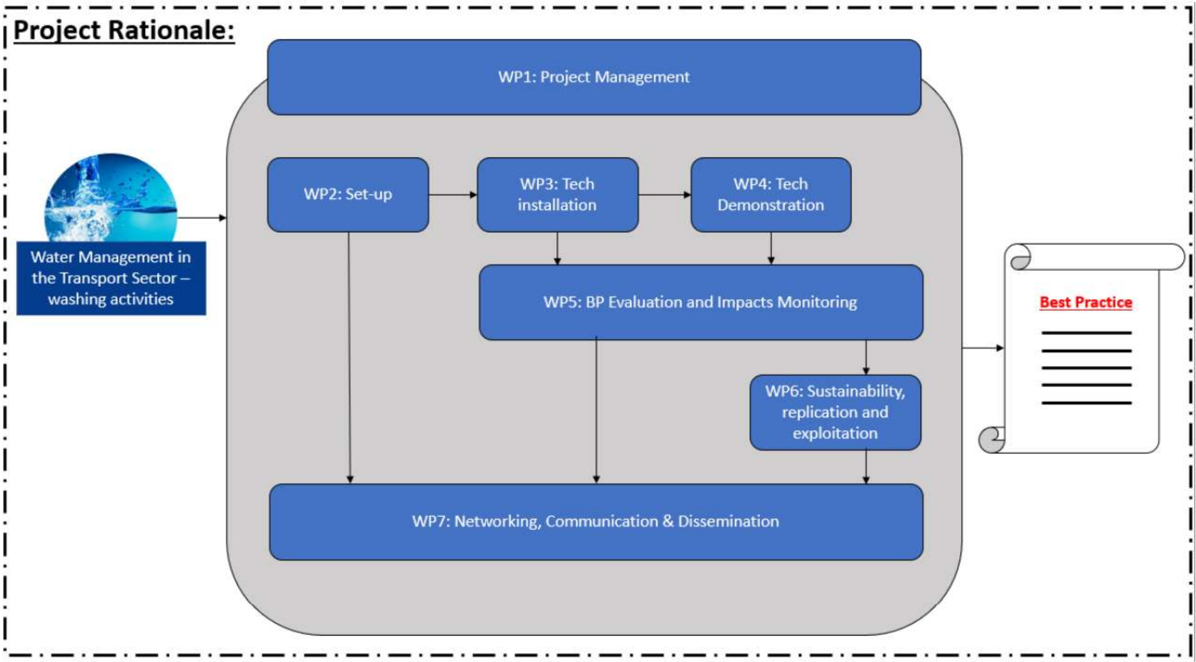

Figure 1 – LIFEH2OBUS rationale

- Implementation phase (13 months duration): WP4 "Technology demonstration" is due after the fleet preparation and includes the activities relative to: technology implementation and monitoring, which include the washing scheduling and overviewing for consumption performances in terms of water, energy and raw materials (wax). This is accompanied by the fleet monitoring, with all the relative parameters, previously defined thanks to La Sapienza. Each partner is responsible for the precise collection of data through this phase which will be essential for the evaluation of the technologies which to be carried in the third, following, phase. Pluservice dedicates its effort in extensively supporting the three Arriva's depots, overviewing the correct functioning of the novel Intelligent Garage System Software (improved by the developed algorithm) and the comprehensive collection of the data, coordinating the partners and leading the way towards the filing of all the activities that will be crucial for the following evaluation phase.
- Overall evaluation and Best Practices phase: WP5 "Best Practice Evaluation and Impacts Monitoring" includes the overall analysis performed by Università La Sapienza, supported by all the other partners of the consortium, allowing for the definition of the technologies to be implemented depending on the environment in which they are used. A comprehensive measurement plan

including the introduction of KPI sets to measure the degree of target achievement. The exhaustive assessment and evaluation between LIFEH2OBUS and no-LIFEH2OBUS scenario will be performed together with a transferability exercise and an environmental analysis based on a Cost-Benefit assessment approach. Illustrative documents are prepared including a throughout review of project activities providing insights and suggestions to simplify the uptake of project results.

2. DELIVERABLE 5.3 RATIONALE

2.1 Introduction

The WP5 process of the LIFEH2OBUS project, guided by the methodological approach established in Del. 5.1 and the performance analysis in Del. 5.2, culminates in this document. While the previous deliverable focused on the analytical interpretation of performance variations at the three Case Studies (LUCs) in Grugliasco, Andor, and Požega, the central scope of Deliverable 5.3 is the "Extract of the project data from the LIFE KPI-webtool." It is important to note that the KPI were renamed to LPI (LIFE Project Indicators) after the project began. Therefore, while the title and deliverable will refer to the original names established in the Amendment, this document strictly refers to the LPI as they are the ones inserted within the now-renamed LIFE LPI webtool.

This deliverable represents the technical culmination of Task 5.7 [KPI Monitoring], an ancillary yet fundamental task that collected, validated, and monitored the project indicators as they evolved through the 12-month test phase. By comparing the “Begin Value” (No-LIFEH2OBUS), the “End Value” (LIFEH2OBUS), and the “Beyond 3 Years Value” (LIFEH2OBUS replication) scenarios, this deliverable provides the final quantitative evidence required to address the two core evaluation issues:

- *Efficiency issue: DQ1 – Are LIFEH2OBUS scenario performance results able to show actual improvements in washing operations?* This addresses the quality of the three LUCs to generate environmental savings (with a specific focus on water, energy, and emissions, consistently with the LIFEH2OBUS project’s gist) and be operationally feasible.
- *Achievement issue: DQ2 – Can success be claimed for the LIFEH2OBUS project?* This examines whether the performance results are sufficient to claim success against the operational targets and the "intelligence" collected for post-project feasibility.

Supervised by La Sapienza University, this document ensures that all performance results, specifically those addressing Efficiency and Achievement, are accurately filed and reported via the LIFE LPI webtool. This data extract serves as the definitive record of the project's success and forms the quantitative basis for WP5 and WP6 Cost-Benefit Analysis (CBA).

2.2 The rationale

The rationale for Deliverable 5.3 is centred on the objective documentation of the "Extract of the project data from the LIFE KPI-webtool." Given that this document serves as the formal repository of the project’s digital reporting, its primary purpose is to provide a transparent and accessible version of the data submitted to the European Commission via the LIFE LPI webtool.

The logic behind this extensive data extract is structured to provide a comprehensive view across all project work areas, including the operational Case Studies in Italy, Hungary, and Croatia, as well as the purely replication-focused scenarios in Roosendal and Jesenice. The inclusion of the full LPI entries ensures a seamless audit trail for the project's performance monitoring.

The technical rationale for this layout includes:

1. *Multi-Scenario Documentation*: By presenting the "Begin," "End," and "Beyond 3 Years" values for each entry, the extract validates the progression from baseline operations to post-project sustainability across all five geographic contexts.
2. *Qualitative Contextualization*: The inclusion of the verbatim comments from the webtool is essential to the rationale of this deliverable. These comments provide the necessary technical explanations, estimation methodologies, and operational context for each value, ensuring that the quantitative data is not interpreted in isolation.
3. *Verification of Replication Potential*: Including the Roosendal and Jesenice data, despite being purely replication-based, is vital to fulfilling the project's commitment to demonstrating transferability (DQ2). This data provides the "intelligence" required to justify the project's long-term environmental and economic impacts.

Under the supervision of La Sapienza University, the filing and reporting of these entries within this document ensures that the information remains fully consistent with the digital records in the LIFE LPI webtool, providing a final snapshot of the LIFEH2OBUS performance.

All project indicators were systematically entered into the digital platform, a process illustrated in the screenshot of the LIFE LPI Webtool (Figure 2). The comprehensive data extract following this rationale is presented in Section 3. It is important to note that the system-generated Excel file could not be embedded directly in this report due to incompatibility between its technical layout and the document's format. Consequently, a specific adaptation was developed for Section 3 to ensure clear, legible reporting of the LPI values and their associated technical comments. For full transparency, the original Exported Excel file will be submitted as a separate technical attachment alongside D5.3.

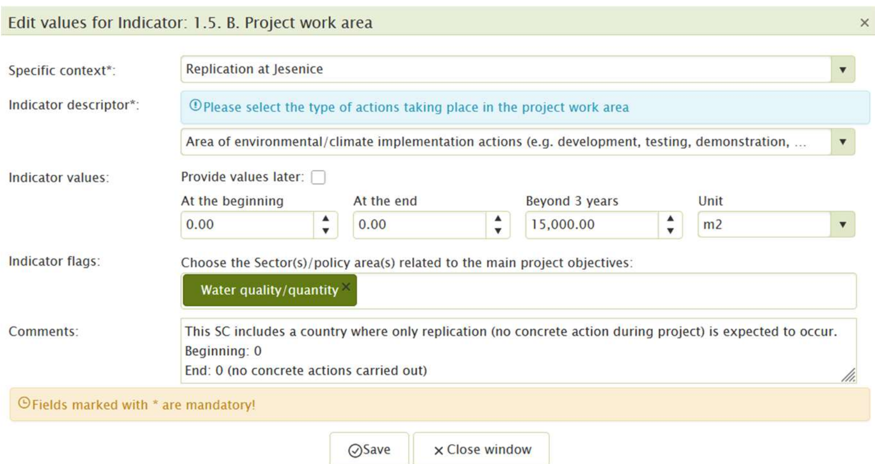

Figure 2 – LIFE LPI Webtool Data Entry

3. LIFE LPI WEBTOOL EXTRACT

1.5 Project work area

Jesenice (Slovenia)
Begin: 0
End: 0
Beyond: 15,000 m2

Comment: This SC includes a country where only replication (no concrete action during the project) is expected to occur.
Beginning: 0
End: 0 (no concrete actions carried out)
Beyond: This is the size of the project work area for the Jesenice depot provided directly by them.

Roosendal (Netherland)
Begin: 0
End: 0
Beyond: 6500 m2

Comment: This SC includes a country where only replication (no concrete action during project) is expected to occur.
Beginning: 0
End: 0 (no concrete actions carried out)
Beyond: This is the size of the project work area for the Roosendal depot provided directly by them.

Croatia
Begin: 0
End: 12,680 m2
Beyond: 126,800 m2

Comment: End-value: at the end of the project, the depot area of Pozega (12680 m2) is considered as the project work area.
Beyond-end value: to estimate this value, we multiply the project work area of Italy and Croatia by 7 and 9, respectively. As mentioned within the GA, we are planning to replicate the activities in the other 7 depots in Italy and the other 9 depots in Croatia.
Average value per depot HR: 12680 m2 (then 12680 x 9 = 114,120, and 114,120 + 12,680 = 126,800).
All calculated by Planimeter.

Hungary
Begin: 0
End: 46,710 m2
Beyond: 46,710 m2

Comment: End-value: at the end of the project, the Budapest depot area of 46710 m2 is considered as the project work area. Calculated by Planimeter.
Beyond-end value does not increase. In fact, in Hungary, there’s only one Arriva-owned depot, which is the same as the one being tested. Indeed, Arriva operates 4 depots in Hungary. However, Arriva Hungary can invest only in the depot it owns. The other three depots are leased, and the washing activity is outsourced, not under Arriva Hungary’s control. There is no possibility of replicating the activities further in Hungary.

Italy
Begin: 0
End: 18,660 m2
Beyond: 149,280 m2

Comment: End-value: at the end of the project, the depot area of Grugliasco (18660 m2) is considered as the project work area.
Beyond-end value: to estimate this value, we multiply the project work area of Italy and Croatia by 7 and 9, respectively. As mentioned within the GA, we are planning to replicate the activities in the other 7 depots in Italy and the other 9 depots in Croatia.
Average value per depot IT: 18660 m2 (then 18660 x 7 = 130,620, and 130,620 + 18,660 = 149,280).
All calculated by Planimeter.

1.6 Humans impacted by the project

Jesenice
Begin: 0
End: 0
Beyond: 21,930

Comment: Beginning value = 0

End value = 0 (no concrete water savings action during the project)

Beyond-end value: population close to the project work area that can benefit from the project's primary outcome (water saving). The assumption is that the water savings achieved by the project measures would impact the population sharing the same freshwater supply. Reference: Republic of Slovenia Statistical Office.

Roosendal
Begin: 0
End: 0
Beyond: 77,840

Comment: Beginning value = 0

End value = 0 (no concrete water savings action during the project)

Beyond-end value: population close to the project work area that can benefit from the project's primary outcome (water saving). The assumption is that the water savings achieved by the project measures would impact the population sharing the same freshwater supply. Reference: Municipality of Roosendal**.**

Croatia
Begin: 0
End: 22,364
Beyond: 124,564

Comment: Beginning value is zero.

End-value: population close to the project work area that can benefit from the project's primary outcome (water saving). The assumption is that the water savings achieved by the project measures would impact the population sharing the same freshwater supply. Reference: Croatian Bureau of Statistics.

Beyond-end value: to estimate this value, we have considered the ratio water-savings-beyond-3-years /water-savings-at-the-end (5.57) as given in LPI 2.4.2 and multiplied it by the number of people positively impacted at the end.

Hungary
Begin: 0
End: 151,812
Beyond: 151,812

Comment: Beginning value is zero.

End-value: population close to the project work area that can benefit from the project's primary outcome (water saving). The assumption is that the water savings achieved by the project measures would impact the population sharing the same freshwater supply. Reference: Croatian Bureau of Statistics.

Beyond-end value: equal to the end-value (no further increment foreseen in Hungary in the afterLIFE - see explanation in LPI 1.5).

Italy
Begin: 0
End: 36,896
Beyond: 205,912

Comment: Beginning value is zero.

End-value: population close to the project work area that can benefit from the project's primary outcome (water saving). The assumption is that the water savings achieved by the project measures would impact the population sharing the same freshwater supply. Reference: Istat.

Beyond-end value: to estimate this value, we have considered the ratio water-savings-beyond-3-years /water-savings-at-the-end (5.58) as given in LPI 2.4.2 and multiplied it by the number of people positively impacted at the end.

2.4.2. B. Water Efficiency - Reduction in new water produced/supplied, due to appropriate water saving measures

Jesenice- Reduction in new water produced/supplied
Begin: 3,744 m3/year
End: 3,744 m3/year
Beyond: 946 m3/year

Jesenice- d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding)

Begin: 0
End: 0
Beyond: 2,798 m3/year

Comment: The baseline is the water consumption of the total bus fleet managed by Arriva in the Jesenice depot, which is 60 buses.
300 litres of water are used to wash a bus (based on the experience of Arriva at the overall EU level); a bus is washed 4 times a week. The baseline is therefore:
60 buses * 0.3 m3 * 4 times a week * 52 weeks/year = 3,744 m3/year (which corresponds to 62.4 m3/year per bus)
The end value is the same as the beginning value as no concrete action will take place at Jesenice during the project (trend warning accepted).

The beyond-end value is calculated considering that in 3 years all buses of Jesenice depot will adopt the water recycling technique with an expected (average) reduction efficiency of 74.73%.
Therefore, the impact in terms of freshwater savings is:
60 buses * 0.7473 * 62.4 m3/year per bus = 2,798 m3/year. Then, beyond-end value is 3,744 – 2,798 = 946 m3/year.

Line d. part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviours that are less water demanding) has been used to clarify the mechanism behind water savings.

Roosendal- Reduction in new water produced/supplied
Begin: 3,307 m3/year
End: 3,307 m3/year
Beyond: 836 m3/year

Roosendal- d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding)

Begin: 0
End: 0
Beyond: 2,471 m3/year

Comment: The baseline is the water consumption of the total bus fleet managed by Arriva in the Roosendal depot, which is 53 buses.
300 litres of water are used to wash a bus (based on the experience of Arriva at the overall EU level); a bus is washed 4 times a week. The baseline is therefore:
53 buses * 0.3 m3 * 4 times a week * 52 weeks/year = 3,307 m3/year (which corresponds to 62.4 m3/year per bus)

The end value is the same as the beginning value as no concrete action will take place at Roosendal during the project (trend warning accepted).

The beyond-end value is calculated considering that in 3 years all buses of Roosendal depot will adopt the mix of LIFEH2OBUS techniques with an expected (average) reduction efficiency of 74.73%. Therefore, the impact in terms of freshwater savings is:
53 buses * 0.7473 * 62.4 m3/year per bus = 2,471 m3/year. Then, beyond-end value is 3,307 – 2,471 = 836 m3/year.

Line d. part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviours that are less water demanding) has been used to clarify the mechanism behind water savings.

Croatia- Reduction in new water produced/supplied
Begin: 29,827 m3/year

End: 25,896 m3/year
Beyond: 7,931 m3/year

Croatia- d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding)

Begin: 0
End: 3,931 m3/year
Beyond: 21,896 m3/year

Comment: The baseline is the water consumption of the total bus fleet managed by Arriva Croatia, i.e. 478 buses.
300 litres of water are used to wash a bus (based on the experience of Arriva at the overall EU level); a bus is washed 4 times a week. The baseline is therefore:
478 buses * 0.3 m3 * 4 times a week * 52 weeks/year = 29,827 m3/year (which corresponds to 62.4 m3/year per bus)

The end value is calculated considering that the 105 buses of the Pozega depot will be washed through a mix of LIFEH2OBUS techniques (harvesting of rainwater; treatment and recycling of wastewater; Waxing Without Water) achieving an overall reduction of 60%.
Therefore, the impact in terms of freshwater savings is:
105 buses * 0.60 * 62.4 m3/year per bus = 3,931 m3/year. Then end value is 29,827 – 3,931 = 25,896 m3/year.

The beyond-end value is calculated considering that in 3 years all 10 Arriva Croatia depots will adopt the mix of LIFEH2OBUS techniques with an expected (average) reduction efficiency of 73.41%. Therefore, the impact in terms of freshwater savings is:
478 buses * 62.4 * 0.7341 m3/year per bus = 21,896 m3/year. Then beyond-end value is 29,827 – 21,896 = 7,931 m3/year.

Line d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding) has been used to clarify the mechanism behind water savings.

The 90% performance target was initially assumed as a general goal for the LIFEH2OBUS initial set of three depots, including the Netherlands facility, all similar in terms of operations. When the Dutch case study was substituted by the Croatian one, the original 90% assumption had to be maintained as a general reference, although the Pozega facility markedly differed (types of vehicles and services operated). Nevertheless, for the 60% reduction achieved in Pozega, success can be claimed, being this result fully consistent with local operations, showing the water saving potential of bus depots of such size.

Hungary- Reduction in new water produced/supplied
Begin: 31,200 m3/year
End: 25,138 m3/year
Beyond: 25,138 m3/year

Hungary- d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding)

Begin: 0
End: 6,062 m3/year
Beyond: 6,062 m3/year

Comment: The baseline is the water consumption of the total bus fleet managed by Arriva Hungary, i.e. 500 buses.
300 litres of water are used to wash a bus (based on the experience of Arriva at the overall EU level); a bus is washed 4 times a week. The baseline is therefore:
500 buses * 0.3 m3 * 4 times a week * 52 weeks/year = 31,200 m3/year (which corresponds to 62.4 m3/year per bus)

The end value is calculated considering that the 130 buses of the Budapest Andor depot will be washed through a mix of LIFEH2OBUS techniques (treatment and recycling of wastewater; Waxing Without Water) achieving an overall reduction of 74.73%.
Therefore, the impact in terms of freshwater savings is:
130 buses * 62.4 * 0.7473 m3/year per bus = 6,062 m3/year. The end value is 31,200 – 6,061 = 25,138 m3/year.

The beyond-end value is the same as the end value as no further replication is foreseen in Hungary (see explanation in LPI 1.5)

Line d. part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding) has been used to clarify the mechanism behind water savings.

Italy- Reduction in new water produced/supplied
Begin: 81,120 m3/year
End: 70,450 m3/year
Beyond: 21,570 m3/year

Italy- d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding)

Begin: 0
End: 10,670 m3/year
Beyond: 59,550 m3/year

Comment: The baseline is the water consumption of the total bus fleet managed by Arriva Italy, i.e. 1,300 buses.
300 litres of water are used to wash a bus (based on the experience of Arriva at the overall EU level); a bus is washed 4 times a week. The baseline is therefore:
1,300 buses * 0.3 m3 * 4 times a week * 52 weeks/year = 81,120 m3/year (which corresponds to 62.4 m3/year per bus)

The end value is calculated considering that the 200 buses of the Grugliasco depot will be washed through a mix of LIFEH2OBUS techniques (harvesting of rainwater; treatment and recycling of wastewater; Waxing Without Water) achieving an overall reduction of 85.5%.
Therefore, the impact in terms of freshwater savings is:
200 buses * 0.855 * 62.4 m3/year per bus = 10,670 m3/year. Then the end value is 81,120 – 10,670 = 70,450 m3/year.

The beyond-end value is calculated considering that in 3 years all 8 Arriva Italy depots will adopt the mix of LIFEH2OBUS techniques with an expected (average) reduction efficiency of 73.41%. Therefore, the impact in terms of freshwater savings is:
1,300 buses * 0.7341 * 62.4 m3/year per bus = 59,550 m3/year. Then beyond-end value is 81,120 – 59,550 = 21,570 m3/year.

Line d. Part of the reduction achieved through reduction/prevention of water demand (e.g. using processes/techniques/behaviors that are less water demanding) has been used to clarify the mechanism behind water savings.

4.1.1.B Primary energy consumption reduction

Jesenice
Begin: 240 MWh/year
End: 240 MWh/year
Beyond: 65 MWh/year

Comment: The baseline is the average energy consumption for each m3 of water pumped from the aquifer (64,2 kWh/m3) = 64.2 kWh * 3,744 m3/year = 240 MWh/year

The end value is the same as the beginning value as no concrete action will take place at Jesenice during the project (trend warning accepted).

The beyond-end value is calculated considering the new amount of fresh water used (beyond end-value of 2.2): 64.2 kWh * 946 m3/year plus an average 1.5 kWh/m3 to pump the recycled water at the depots. This gives a final energy consumption of 65 MWh/year, with an impact (reduction of energy consumption from the baseline) of 175 MWh/year.

Roosendal
Begin: 212 MWh/year
End: 212 MWh/year
Beyond: 57 MWh/year

Comment: The baseline is the average energy consumption for each m3 of water pumped from the aquifer (64,2 kWh/m3) = 64.2 kWh * 3,307 m3/year = 212 MWh/year

The end value is the same as the beginning value as no concrete action will take place at Roosendal during the project (trend warning accepted).

The beyond-end value is calculated considering the new amount of fresh water used (beyond end-value of 2.2): 64.2 kWh * 836 m3/year plus an average 1.5 kWh/m3 to pump the recycled water at the depots. This gives a final energy consumption of 57 MWh/year, with an impact (reduction of energy consumption from the baseline) of 155 MWh/year.

Croatia
Begin: 1,915 MWh/year
End: 1,663 MWh/year
Beyond: 542 MWh/year

Comment: The baseline is the average energy consumption for each m3 of water pumped from the aquifer (64,2 kWh/m3) = 64.2 kWh * 29,827 m3/year = 1,915 MWh/year

The end value is calculated considering the new amount of fresh water used (end-value of 2.2): 64.2 kWh * 25,896 m3/year =1,663 MWh/year, plus an average 1.5 kWh/m3 to pump the recycled water at the Pozega depot. This gives a final energy consumption of 1,668 MWh/year, with an impact (reduction of energy consumption from the baseline) of 246 MWh/year.

The beyond-end value is calculated considering the new amount of fresh water used (beyond end-value of 2.2): 64.2 kWh * 7,931 m3/year plus an average 1.5 kWh/m3 to pump the recycled water at all 10 Croatian depots. This gives a final energy consumption of 542 MWh/year, with an impact (reduction of energy consumption from the baseline) of 1,372 MWh/year.

Hungary
Begin: 2,003 MWh/year
End: 1,623 MWh/year
Beyond: 1,623 MWh/year

Comment: The baseline is the average energy consumption for each m3 of water pumped from the aquifer (64,2 kWh/m3) = 64.2 kWh * 31,200 m3/year = 2,003 MWh/year

The end value is calculated considering the new amount of fresh water used (end-value of 2.2): 64.2 kWh * 25,138 m3/year =1,614 MWh/year, plus an average 1.5 kWh/m3 to pump the recycled water at the Budapest depot. This gives a final energy consumption of 1,623 MWh/year, with an impact (reduction of energy consumption from the baseline) of 389 MWh/year.

The beyond-end value is the same as the end value as no further replication is foreseen in Hungary (see explanation in LPI 1.5).

Italy
Begin: 5,208 MWh/year
End: 4,523 MWh/year
Beyond: 1474 MWh/year

Comment: The baseline is the average energy consumption for each m3 of water pumped from the aquifer (64,2 kWh/m3) = 64.2 kWh * 81,120 m3/year = 5,208 MWh/year

The end value is calculated considering the new amount of fresh water used (end-value of 2.2): 64.2 kWh * 70,449 m3/year = 4,523 MWh/year, plus an average 1.5 kWh/m3 to pump the recycled water at the Grugliasco depot. This gives a final energy consumption of 4,539 MWh/year, with an impact (reduction of energy consumption from the baseline) of 669 MWh/year.

The beyond-end value is calculated considering the new amount of fresh water used (beyond end-value of 2.2): 64.2 kWh * 21,570 m3/year plus an average 1.5 kWh/m3 to pump the recycled water at all 8 Italian depots. This gives a final energy consumption of 1474 MWh/year, with an impact (reduction of energy consumption from the baseline) of 3734 MWh/year.

8.1.B Reduction of greenhouse gas emissions

Jesenice- GHG
Begin: 51 Tons of CO2eq/ year
End: 51 Tons of CO2eq/ year
Beyond: 14 Tons of CO2eq/ year

Jesenice- GHG per bus
Begin: 845 kg CO2eq/ bus
End: 845 kg CO2eq/ bus
Beyond: 228 kg CO2eq/ bus

Comment: The baseline is the average CO2eq emissions for energy consumption at the beginning. The conversion rate used for the energy mix, provided by EEA for Slovenia 2021 ((https://www.eea.europa.eu/ims/greenhouse-gas-emission-intensity-of-1)) is 0.211
kgCO2eq/kWh. Therefore (see 4.1.1):

240 MWh/year * 0.211 kgCO2eq/kWh = 51 tons CO2eq/year.
Assuming as 'unit' the GHG emissions to wash one bus and remembering that the total number of buses in Jesenice is 60 we have:
51 tons CO2eq/year / 60 buses = 845 kg of CO2eq/(year*bus) – with decimals rounding.

The end value is the same as the beginning value as no concrete action will take place at Jesenice during the project (trend warning accepted).

The beyond-end value is calculated considering the average CO2eq emissions for the reduced energy consumption at the Jesenice depot. Therefore (see 4.1.1):
65 MWh/year * 0.211 kgCO2eq/kWh = 14 tons CO2eq/year, with a reduction of 37 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
14 tons CO2eq/year / 60 buses = 228 kg of CO2eq/(year*bus)

Roosendal– GHG
Begin: 72 Tons of CO2eq/ year
End: 72 Tons of CO2eq/ year
Beyond: 19 Tons of CO2eq/ year

Roosendal- GHG per bus
Begin: 1,354 kg CO2eq/ bus
End: 1,354 kg CO2eq/ bus
Beyond: 365 kg CO2eq/ bus

Comment: The baseline is the average CO2eq emissions for energy consumption at the beginning. The conversion rate used for the energy mix, provided by EEA for the Netherland 2021 ((https://www.eea.europa.eu/ims/greenhouse-gas-emission-intensity-of-1)) is 0.338
kgCO2eq/kWh. Therefore (see 4.1.1):
212 MWh/year * 0.338 kgCO2eq/kWh = 72 tons CO2eq/year.
Assuming as 'unit' the GHG emissions to wash one bus and remembering that the total number of buses in Roosendal is 53 we have:
72 tons CO2eq/year / 53 buses = 1,354 kg of CO2eq/(year*bus)

The end value is the same as the beginning value as no concrete action will take place at Roosendal during the project (trend warning accepted).

The beyond-end value is calculated considering the average CO2eq emissions for the reduced energy consumption at the Roosendal depot. Therefore (see 4.1.1):
57 MWh/year * 0.338 kgCO2eq/kWh = 19 tons CO2eq/year, with a reduction of 52 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
19 tons CO2eq/year / 53 buses = 365 kg of CO2eq/(year*bus)

Croatia - GHG
Begin: 272 Tons of CO2eq/ year
End: 237 Tons of CO2eq/ year
Beyond: 72 Tons of CO2eq/ year

Croatia - GHG per bus
Begin: 569 kg CO2eq/ bus

End: 496 kg CO2eq/ bus
Beyond: 151 kg CO2eq/ bus

Comment: The baseline is the average CO2eq emissions for energy consumption at the beginning. The conversion rate used for the energy mix, provided by EEA for Croatia 2021 ((https://www.eea.europa.eu/ims/greenhouse-gas-emission-intensity-of-1)) is 0.142
kgCO2eq/kWh. Therefore (see 4.1.1):
1,915 MWh/year * 0.142 kgCO2eq/kWh = 272 tons CO2eq/year.
Assuming as 'unit' the GHG emissions to wash one bus and remembering that the total number of buses in Croatia is 478 we have:
272 tons CO2eq/year / 478 buses = 569 kg of CO2eq/(year*bus)

The end value is calculated considering the average CO2eq emissions for the reduced energy consumption at the Pozega depot. Therefore (see 4.1.1):
1,668 MWh/year * 0.142 kgCO2eq/kWh = 237 tons CO2eq/year, with a reduction of 35 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
237 tons CO2eq/year / 478 buses = 496 kg of CO2eq/(year*bus)

The beyond-end value is calculated considering the average CO2eq emissions for the reduced energy consumption at all 10 Croatian depots. Therefore (see 4.1.1):
509 MWh/year * 0.142 kgCO2eq/kWh = 72 tons CO2eq/year, with a reduction of 200 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
72 tons CO2eq/year / 478 buses = 151 kg of CO2eq/(year*bus)

Hungary - GHG
Begin: 391 Tons of CO2eq/ year
End: 316 Tons of CO2eq/ year
Beyond: 323 Tons of CO2eq/ year

Hungary - GHG per bus
Begin: 781 kg CO2eq/ bus
End: 633 kg CO2eq/ bus
Beyond: 633 kg CO2eq/ bus

Comment: The baseline is the average CO2eq emissions for energy consumption at the beginning. The conversion rate used for the energy mix, provided by EEA for Hungary 2021 ((https://www.eea.europa.eu/ims/greenhouse-gas-emission-intensity-of-1)) is 0.195
kgCO2eq/kWh. Therefore (see 4.1.1):
2,003 MWh/year * 0.195 kgCO2eq/kWh = 391 tons CO2eq/year.
Assuming as 'unit' the GHG emissions to wash one bus and remembering that the total number of buses in Hungary is 500 we have:
391 tons CO2eq/year / 500 buses = 781 kg of CO2eq/(year*bus)

The end value is calculated considering the average CO2eq emissions for the reduced energy consumption at the Budapest Andor depot. Therefore (see 4.1.1):
1,623 MWh/year * 0.195 kgCO2eq/kWh = 316 tons CO2eq/year, with a reduction of 75 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
316 tons CO2eq/year / 500 buses = 633 kg of CO2eq/(year*bus)

The beyond-end value is the same as the end value as no further replication is foreseen in Hungary (see explanation in LPI 1.5).

Italy - GHG
Begin: 1,286 Tons of CO2eq/ year
End: 1,117 Tons of CO2eq/ year
Beyond: 361 Tons of CO2eq/ year

Italy - GHG per bus
Begin: 990 kg CO2eq/ bus
End: 859 kg CO2eq/ bus
Beyond: 278 kg CO2eq/ bus

Comment: The baseline is the average CO2eq emissions for energy consumption at the beginning. The conversion rate used for the energy mix, provided by EEA for Italy 2021 ((https://www.eea.europa.eu/ims/greenhouse-gas-emission-intensity-of-1)) is 0.247
kgCO2eq/kWh. Therefore (see 4.1.1):
5,208 MWh/year * 0.247 kgCO2eq/kWh = 1,286 tons CO2eq/year.
Assuming as 'unit' the GHG emissions to wash one bus and remembering that the total number of buses in Italy is 1,300 we have:
1,286 tons CO2eq/year / 1,300 buses = 990 kg of CO2eq/(year*bus)

The end value is calculated considering the average CO2eq emissions for the reduced energy consumption at the Grugliasco depot. Therefore (see 4.1.1):
4,523 MWh/year * 0.247 kgCO2eq/kWh = 1,117 tons CO2eq/year, with a reduction of 169 of tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
1,117 tons CO2eq/year / 1,300 buses = 859 kg of CO2eq/(year*bus)

The beyond-end value is calculated considering the average CO2eq emissions for the reduced energy consumption at all 8 Italian depots. Therefore (see 4.1.1):
1474 MWh/year * 0.247 kgCO2eq/kWh = 364 tons CO2eq/year, with a reduction of 753 tons CO2eq/year.
Keeping constant the number of buses to wash, GHG emissions to wash one bus is reduced to:
364 tons CO2eq/year / 1,300 buses = 280 kg of CO2eq/(year*bus)

10.2.B Governance

- No. of stakeholder entities involved.

Volunteers (individuals)
Begin: 0
End: 0
Beyond: 0

Policy makers (individuals)
Begin: 0
End: 0
Beyond: 0

Public bodies (stakeholder entities)
Begin: 0

End: 3
Beyond: 3

Consultancies or consultants (individuals or entities)
Begin: 0
End: 2
Beyond: 2

Other individual stakeholders (e.g. professionals, experts, to be specified in the comments box)
Begin: 0
End: 3
Beyond: 3

Comment: The project produced a 'Transferability exercise and plan' as a one-off tool to assess the acceptance and attractiveness of the innovation proposed in the immediacy of its launch. The total number of stakeholders was 8. Participants in the exercise were also expert volunteers (academicians, transport planners and managers, operators, etc.) recruited from UNIROMA La Sapienza. The Public Bodies stakeholders are from the following organisations: ASSTRA (Italian public transport operators association), UITP (public transport operators associations), and Transport Infrastructure Ireland. The consultants belong to the following: Nais Solutions and TTS Italia (Italian ITS-providers associations for public transport). Finally, the other individual stakeholders belong to the following organisations: Polytechnic of Bari- School of Engineering, Polytechnic of Madrid- School of Engineering, Transport Infrastructure Ireland, and Laboratoire Ampère- Université de Lyon-INSA Lyon- École Centrale de Lyon.

It is not in the methodology to be replicated again after 3 years.

(For the Transferability methodology, please refer to: Musso, A., Corazza, M. V., Visioning the bus system of the future: stakeholders' perspective, Transportation Research Record, n. 2533, 2015, pp. 109–117, doi: 10.3141/2533-12)

<u>11.1.B Website</u>

- Number of unique website visits

Begin: 0
End: 1000
Beyond: 2000

Comment: The figures have been collected from the partners. The content has been hosted across several websites rather than a single domain. It was estimated that approximately 1.000 unique visits occurred during the project, with traffic continuing for a few years, primarily driven by legacy content and references on partner sites.

<u>11.2.B Other tools for reaching/raising awareness</u>

- Number of outcomes (e.g. nr of reports, events, etc)

Number of different publications made (Journal/conference)
Begin: 0
End: 6
Beyond: 8

Comment: The number of presentations of scientific papers at international conferences and publications in high-impact journals at the end of the project was six. The scientific papers were published in the following journals: Journal of Cleaner Production, Transportation Engineering, Transportation Research Procedia (3 times), and 2023 IEEE International Conference on Environment and Electrical Engineering and 2023 IEEE Industrial and Commercial Power Systems Europe (EEEIC/ I&CPS Europe). Beyond the project, at least two more are planned.

Number of events/exhibitions organised
Begin: 0
End: 4
Beyond: 4

Comment: The consortium organized a series of dissemination events during the project, including open events in Italy, Hungary and Croatia, as well as a final conference at the end of the project.

These events were designed to present the project scope, structure and expected outcomes, while the final conference provided a comprehensive overview of project implementation, results and key findings.
The open events involved industrial stakeholders from the transport and wastewater treatment sectors, together with policy makers, regulators and academic partners, ensuring broad stakeholder engagement across the participating countries.

Number of different displayed information created (posters, information boards)
Begin: 0
End: 6
Beyond: 8

Comment: Info boards of appropriate size, with European flag, funding statement and special logo (LIFE logo) will be produced at the 3 project sites. Plus, 2 additional posters displayed at Torino Porta Nuova and Torino Porta Susa.
Beyond 3 years, info boards will be also erected at Jesenice and Roosendal.
A scientific poster was presented at a major in scientific event.

Other distinct media products created (e.g. different videos/broadcast/leaflets)
Begin: 0
End: 4
Beyond: 4

Comment: One video on the Grugliasco system (available in IT and EN – considered one media type). No leaflets or brochures planned. We can confirm at two types of social media: LinkedIn, and Facebook.
Additionally, the final event produced a dedicated flyer, which is included in the final communication materials.

<u>11.3. B. Surveys carried out to assess awareness and behavior change regarding the environmental/climate problem addressed</u>

General public individuals (citizens, consumers, household owners, etc)
Begin: 0
End: 165
Beyond: 165

Comment: Questionnaires were delivered to assess acceptance of the washing technology among the passengers.

Other employees/individuals or entities (to be specified in the comments box...)
Begin: 0
End: 57
Beyond: 57

Comment: Questionnaires were delivered to assess acceptance of the washing technology among the staff.

12.1.B Networking and synergies with projects/initiatives

- Other projects or initiatives (nationally/regionally/privately funded; to be specified in the comments box...)

Begin: 0
End: 1
Beyond: 1

Comment: UITP Research in Mobility Committee. Invited to the final event of the Sapienza beneficiaries in the LIFE OPTIMUS project.

13.B New jobs created

Begin: 0
End: 2
Beyond: 10

Comment: Arriva, within the project, added 2 FTE.
The replication plan foresees to involve all Arriva's Italian depots (8), all Arriva's Croatian depots (10), totalling 16 new depots, plus depots in Slovenia and the Netherlands. After 3 years, LIFEH2OBUS intends to l create new jobs, reasonably, for 10 new FTE in comparison to the beginning of the project.

14.1.B Revenue during or after project end, due to project outcomes

Begin: 0 €
End: 0 €
Beyond: 28,500 €

Comment: Revenues from sales the Pluservice software. Projected to be 8.5 k€ in 2026, 8.5 k€ in 2027, and 10.5 k€ in 2028.

14.2.B Catalytic effect - Financial - Cumulative investments triggered or finance accessed

Begin: 0 €
End: 0 €
Beyond: 4,702,140 €

Comment: Post-LIFE cumulative investments will be covered by beneficiary own-contribution. These investments could be split by country, but the use of the more general context brings about a better picture of the global economic figures involved. Calculation rationale is the following for all countries:

Total investment costs = Unit cost of a LIFEH2OBUS innovative washing facility * number of new washing facilities after 3 years.

Considering that the cost of a new washing facility is €261,230 for all countries where replication is foreseen (18 new facilities in total), the total cost for replication is €4,702,140.

14.3.1. B. Continuation after the project-end in the same premises/area(s) as those used during the project

Comment: The replication phase foresees the implementation of the project in 16 new depots (7 in Italy and 9 in Croatia).

14.3.3. B. Catalytic effect - Spatial - Replication of the same technical approach into new geographic areas
Number of replications

Roosendal
Beyond: 1

Jesenice
Beyond: 1

End of the document