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REPORT ON PILOT ACTION 3 EVALUATION PHASE

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A. INTRODUCTION AND EVALUATION FRAMEWORK

This deliverable constitutes the evaluation phase of Pilot Action 3 (Activity A2.3, Output O2.3, Investment I2.3) implemented by the City of Karlovac at the City Administration building, Banjavčićeva 9, within the Interreg Central Europe project ZEB4ZEN. It builds on **D.2.3.1 – Report on Pilot Action 3 Preparation Phase** and **D.2.3.2 – Report on Pilot Action 3 Implementation Phase**, and evaluates the system **as actually commissioned** (PV plant handed over on 3 June 2026, energy management software on 29 May 2026, bidirectional charger on 19 December 2025, electric vehicle on 24 February 2026).

The evaluation covers: (1) the final configuration of the implemented system; (2) technical performance and operational functionality; (3) PV electricity production and energy management results; (4) electric vehicle integration and the actual bidirectional charging functionality; (5) financial and (6) environmental evaluation; (7) deviations from the original investment concept; and (8) lessons learned and transferability. The quantification of savings follows the Monitoring, Reporting and Verification (MRV) methodology of **Deliverable D.2.4.3**, with Croatian conversion factors.

Revision note (Version 2, October 2026). Following the comments of the Joint Secretariat, this version has been revised to reflect the actually commissioned system, to report operational data from the monitoring platform, and to distinguish clearly between measured results and estimates. Values presented as "measured" in Version 1 that were in fact design or methodology estimates have been relabelled, and investment costs have been aligned with the signed contracts.

Classification of results. Each figure in this report is labelled as follows:

- **M** – **measured**: values recorded by the SenzoriKA monitoring platform (PV inverter, EV charger) or established in handover records and functional tests;
- **E** – **estimated / design**: values from the Main Design, the feasibility study (Grid ONE, 2024) or manufacturer data;
- **C** – **calculated**: annual savings calculated with the MRV methodology (D.2.4.3) on the basis of design parameters; they are ex-ante calculations, not measurements.

Evaluation period. Monitoring data are available from the start of operation of the PV plant at the beginning of June 2026. Because the observed period covers only part of a year, annual results are still calculated values; measured values are reported for the period available and will be complemented with a full year of data (June 2026 – May 2027) by the City of Karlovac after the project end.

B. FINAL CONFIGURATION OF THE IMPLEMENTED SYSTEM

The implemented system combines local renewable generation, electric mobility used as a mobile energy resource, bidirectional-ready charging infrastructure and digital monitoring and energy management in one public building located in the heritage-protected historic centre. The configuration as commissioned is summarised in Table 1.

Table 1: Final configuration of the implemented system

Component	As-built characteristics	Contractor / handover	Type
Rooftop PV plant	26 modules × 450 Wp = **11.7 kWp**; inverter rated power 10 kW; red (roof-coloured) modules on roof surfaces not visible from the street, as required by the conservator; grid-tied, self-consumption configuration on the building LV installation	ĐURO ĐAKOVIĆ ELEKTROMONTAŽA d.o.o.; handover **03.06.2026**	**M** (handover) / **E** (ratings)
Bidirectional charging station	Bidirectional (V2G-ready) EV charger, developed in Italy, installed in the existing EV parking space at the City Hall; DSO approval for bidirectional connection obtained; operated in charging mode	NEOS d.o.o.; works completed 15.12.2025, handover **19.12.2025**	**M**
Electric vehicle	BYD SEAL U Comfort battery-electric vehicle with **V2L (vehicle-to-load)** function; municipal fleet vehicle and mobile energy resource	AUTO HRVATSKA AUTOMOBILI d.o.o.; delivered and V2L tested **24.02.2026**	**M**
Energy management / monitoring	SenzoriKA platform: acquisition and visualisation of PV inverter data (power, daily and cumulative energy) and EV charger data (hourly/daily/monthly/annual energy), alarms, public display in the City Hall lobby, web dashboard	KONČAR – Digital d.o.o.; handover **29.05.2026**	**M**
Stationary battery	**Not installed** – replaced by the EV as mobile storage (fire-protection constraints and cost, see D.2.3.2, Chapter B)	-	-

Functional scheme. PV electricity is consumed directly by the building loads (office equipment, lighting, HVAC auxiliaries) and, during office hours, can be used to charge the electric vehicle at the bidirectional charger. When parked at the City Hall, the vehicle can supply selected building loads (e.g. IT equipment, emergency lighting or other small loads of approx. 2–3 kW) through its V2L output, acting as a mobile energy resource and back-up source. The SenzoriKA platform monitors PV production and EV charging and presents the results to staff and visitors. Energy injection from the vehicle into the building installation or the grid **through the charger** (V2G/V2H) is not active, because the vehicle does not support it (Chapter E).



Figure 1: PV plant with roof-coloured modules on the City Hall roof (June 2026)

C. TECHNICAL PERFORMANCE AND OPERATIONAL FUNCTIONALITY

Table 2 summarises the verified functionality of each component of the commissioned system, the evidence on which it is based and the date of verification.

Table 2: Operational functionality of the commissioned system

Function	Status	Evidence / date	Type
PV plant – production and grid-tied operation	Operational	Handover record 03.06.2026; continuous inverter data in SenzoriKA from early June 2026	M
PV plant – permanent operation	Operational	Permit No. 4017-70342059-800001532 defining permanent operation from 26.06.2026.	M
Bidirectional charger – EV charging	Operational	Functional test before handover; handover record 19.12.2025; charging sessions logged in SenzoriKA (first logged session 09.06.2026)	M
Bidirectional charger – discharge (V2G/V2H)	**Not active**	No V2G/V2H-capable vehicle available on the market; charger hardware is bidirectional-ready	-
EV – V2L supply of building loads	Operational	V2L function tested at vehicle handover 24.02.2026	M
Monitoring and visualisation (EMS)	Operational	Handover record 29.05.2026; web dashboard and public display in operation (June 2026)	M
Automated optimisation / control of charging	Not active	Charging is scheduled manually. All PV electricity is consumed directly by the building loads and only negligable surplus was generated as described in D.2.	-

The PV plant has operated stably since commissioning. Inverter data for mid-June 2026 show the typical clear-sky daily profile with daily peak output between approx. 7 and 9 kW (maximum ≈ 9 kW against 11.7 kWp installed and 10 kW rated inverter power) and reduced output on cloudy days (Figure 2) [**M**]. The ratio of peak output to installed power is consistent with a roof installation with orientations of 135°, 225° and 315° and a 35° pitch, as determined in the feasibility study. The monitoring chain (inverter – SenzoriKA – dashboard/public display) is functional; communication of PV and charger data has been stable since June 2026.

The bidirectional charger has been operational since December 2025 and is used for charging the municipal electric vehicle. Because V2G is not available for the vehicle, the system cannot discharge the vehicle through the charger; the reverse energy flow is realised through the vehicle's V2L function (see Chapter E). The contribution of the vehicle as an energy resource is therefore limited by its availability (it is also used for transport), its state of charge and the V2L output power, and it is not dispatched automatically by the EMS.

D. PV ELECTRICITY PRODUCTION AND ENERGY MANAGEMENT RESULTS

D.1 Measured PV production

The SenzoriKA platform records cumulative PV energy from the inverter. On **18 June 2026 at 11:40** the cumulative production since the start of operation was **698.9 kWh [M]**. Between 12 and 18 June 2026 the cumulative counter rose from approx. 356 kWh to 698.9 kWh, i.e. approx. **50–55 kWh per day** (≈ 4.5 kWh per kWp and day) **[M]**. For comparison, the design annual yield of 13,964 kWh **[E]** corresponds to roughly 55–60 kWh per day in June (assuming a typical monthly distribution for continental Croatia) **[E]**, so the first measured values are consistent with the design expectations.

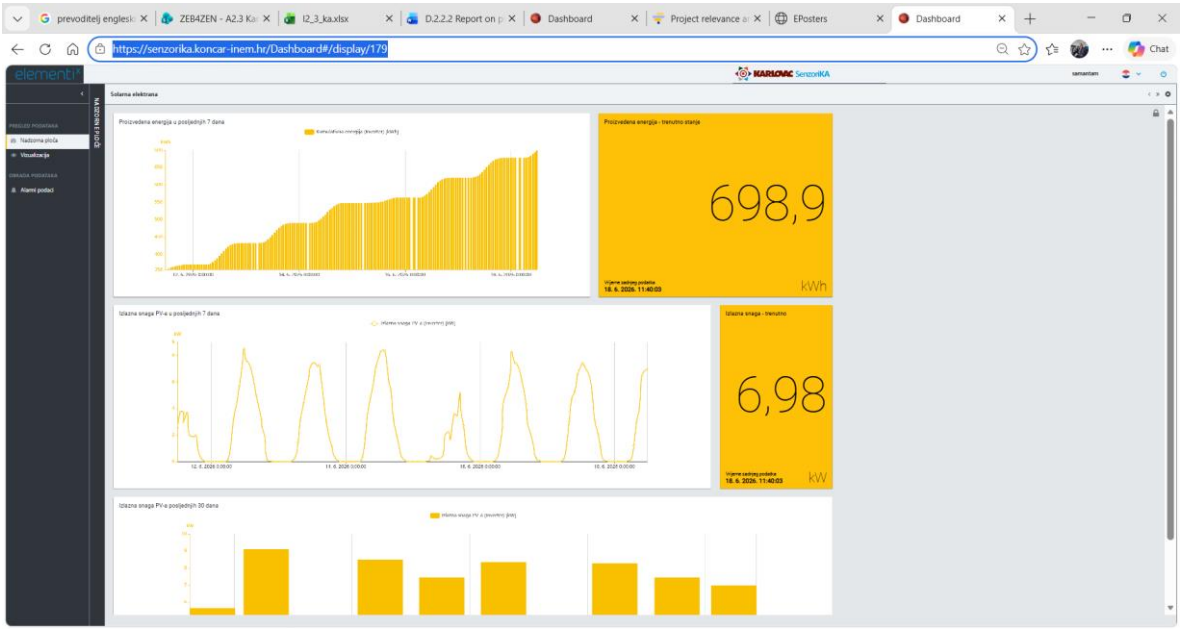

Figure 2: SenzoriKA – cumulative PV energy and PV output power, 12–18 June 2026 (measured)

Table 3: Measured monthly results (to be completed from the SenzoriKA monitoring platform)

Month (2026)	Measured PV production (kWh)	Specific yield (kWh/kWp)	Measured EV charging energy (kWh)	Source
June (from start of operation)	1,116.92	95.46	182.93	SenzoriKA export
July	1,489.05	127.27	31.04	SenzoriKA export
August	1,480.43	126.53	48.93	SenzoriKA export
September	1,231.30	105.24	119.36	SenzoriKA export
October	878.55	75.09	58.93	SenzoriKA export
Total June – October 2026	6,196.25	529.59	441.19	

When measured monthly results are taken into account, it can be seen that average daily energy production in months were as following

July: 48.03 kWh per day

August: 47.75 kWh

September: 41.03 kWh

October: 28.32 kWh

Annual PV production for the as-built plant is estimated at **13,964 kWh/year** according to the Main Design [**E**]. For the MRV calculation (D.2.4.3) a more conservative value of **11,466 kWh/year** is used (11.7 kWp × 1,400 full-load hours × performance ratio 0.70) [**C**]. Measured monthly values (Table 3) will be used to verify these figures once a full year of operation is available. Judging by data collected so far, and assuming a typical monthly distribution for continental Croatia, previously given conservative value should be achieved without a tight margin.

D.2 Energy management results

The energy management system was commissioned on 29 May 2026 and provides the City of Karlovac, for the first time, with continuous data on local PV generation and EV charging. Its implemented functions are: (i) real-time and historical monitoring of PV output power and energy; (ii) metering of EV charging energy per hour, day, month and year; (iii) alarms; and (iv) public visualisation for staff and visitors on a display in the City Hall lobby (Figure 3), which also fulfils the programme visibility requirements. The first EV charging session was logged on **9 June 2026** (19.69 kWh charged between 09:00 and 10:00, i.e. during PV production hours) [**M**].

Self-consumption: the PV plant (10 kW inverter) is small compared with the building load (contracted connection power 140 kW, estimated installed electrical load of approx. 145 kW, about 30 split air-conditioning units), so during office hours practically all PV electricity is expected to be consumed on site [**E**]; the MRV calculation assumes 0 % export.

The actual share of exported electricity was verified from the bidirectional DSO meter, for the period June till October. In that period, meter recorded 5.44 kWh total energy exported to grid, which is a negligible amount comparing to total building consumption in that period. Initial assumption of 0% export is very close to actual result.

Peak-demand reduction and load shifting through EV charging cannot yet be quantified from measurements, because the building main meter is not integrated in the monitoring platform; the peak-reduction values of the feasibility study (Chapter E) remain estimates.

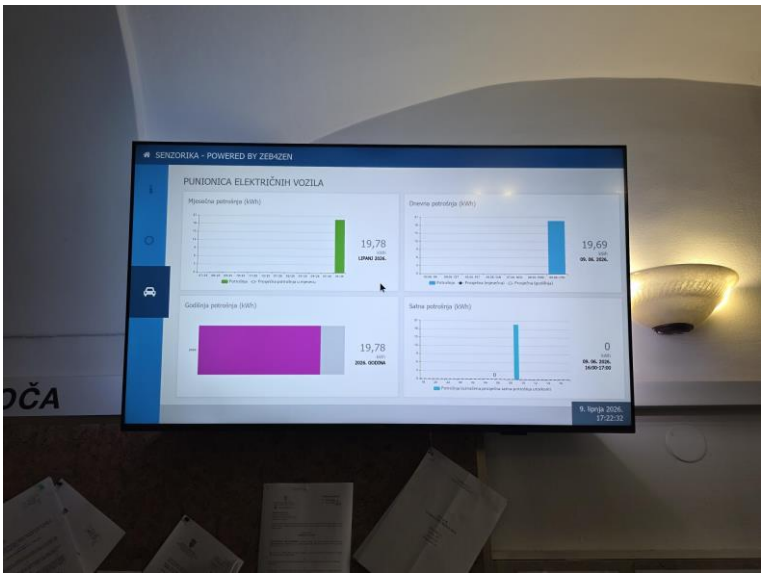

Figure 3: Public display in the City Hall lobby – EV charger module, 9 June 2026 (measured data)

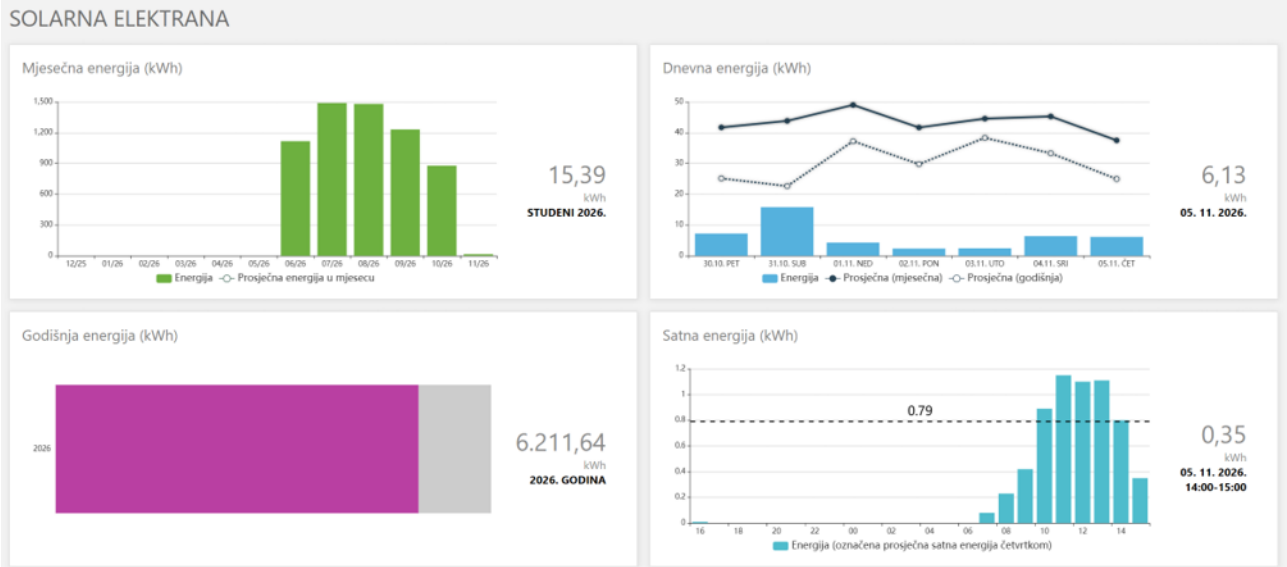

Figure 4: Screenshot of public display in the City Hall lobby – PV charger module, 5 November 2026 (measured data)

E. ELECTRIC VEHICLE INTEGRATION AND ACTUAL BIDIRECTIONAL CHARGING FUNCTIONALITY

The electric vehicle (BYD SEAL U Comfort) was delivered on 24 February 2026 and is part of the municipal fleet. Its integration into the pilot works as follows:

- **Charging (grid/PV-to-vehicle) - implemented and operational.** The vehicle is charged at the bidirectional charger at the City Hall; charging is metered and displayed in the SenzoriKA platform. Charging during office hours uses electricity at times when PV generation is available.
- **Vehicle-to-load (V2L) - implemented and tested.** The V2L function was tested at the handover of the vehicle (24.02.2026). Through its V2L output the vehicle can supply selected low-power building loads directly (IT equipment, emergency lighting, other small loads of approx. 2–3 kW), e.g. during grid outages or as short-term support, so that the vehicle acts as a mobile energy resource. It has been decided that the vehicle will not used in V2L function as it does not represent significant load reduction. Furthermore, this function is not automatic and require manual intervention that is not justified by such small load reduction. This will be revised once the V2G vehicle is available, and also automated peak shaving function implemented.
- **Bidirectional charging through the charger (V2G / V2H) - not operational.** Although the installed charger is bidirectional and its connection was approved by the DSO, energy cannot be returned from the vehicle to the building or the grid through the charger, because no vehicle with an enabled V2G function is available on the Croatian or Central European market (V2G is software-enabled by manufacturers only in selected markets) and the Croatian regulatory framework for V2G is still being developed. This was the reason for the approved modification from V2G to V2L (31 October 2025).

The actual bidirectional functionality of the pilot is therefore achieved **through V2L, not through the charger**. The charger represents a future-proof investment: it can be used for V2G/V2H operation as soon as compatible vehicles and rules become available, without additional infrastructure works. The flexibility effects modelled in the feasibility study for an EV used as storage (peak power reduced from 50 kW to 36 kW, annual costs reduced by 22 %) assumed automatic charging and discharging through the charger; they are **estimates for a configuration that is not yet possible** and must not be read as results of the commissioned system [**E**].



Figure 5: BYD SEAL U Comfort with V2L function at the City Hall (February 2026)

F. FINANCIAL EVALUATION

F.1 Actual investment costs

Table 4: Actual investment costs according to signed contracts [M]

Component	Contractor	Contract value excl. VAT (EUR)	Incl. VAT (EUR)
PV plant (contract 29.01.2026 + Annex 2 additional works)	ĐURO ĐAKOVIĆ ELEKTROMONTAŽA d.o.o.	15,247.67 (12,409.16 + 2,838.51)	15,247.67
Bidirectional charging station	NEOS d.o.o.	16,540.00	20,675.00
Energy management software	KONČAR – Digital d.o.o.	15,890.00	19,862.50
Electric vehicle with V2L	AUTO HRVATSKA AUTOMOBILI d.o.o.	33,500.00	41,875.00
Total equipment and works		**81,177.67**	**97,660.17**
Preparatory services (feasibility study, design amendment)	Grid ONE d.o.o.; designer	4,000.00 + 900.00	5,000.00 + 1,125.00

The investment costs reported in Investment Factsheet I2.3 (equipment CC5 and infrastructure and works CC6) amount to **EUR 97,660.17**. The investment in the PV plant is reported without VAT, in accordance with the applicable VAT legislation.

F.2 Estimated annual savings and payback

Annual financial savings are calculated with the MRV methodology for the two measures that produce quantifiable energy savings – PV generation and replacement of a petrol vehicle by the electric vehicle – using an electricity price of 0.131 EUR/kWh and a petrol price of 1.64 EUR/l [**C**]. The payback periods are based on the **actual** contract values (Version 1 used a placeholder investment of EUR 15,500 for both measures).

Table 5: Estimated annual savings and simple payback

Measure	Annual saving (EUR/y)	Investment (EUR, excl. VAT)	Simple payback (years)	Lifetime (years)	Type
PV plant - MRV yield 11,466 kWh/y	1,502.05	15,247.67	10.2	23	C
PV plant - design yield 13,964 kWh/y	1,829.28	15,247.67	8.3	23	C
Electric vehicle (replacing a petrol car, 12,650 km/y)	1,114.40	33,500.00	30.1	8	C
PV + EV (MRV)	**2,616.45**	**48,747.67**	**18.6**	-	C

The PV plant is economically viable on its own (payback of 8–10 years against a lifetime of 23 years). The electric vehicle does not pay back from fuel savings alone within its lifetime; its justification is its dual use – municipal transport plus mobile energy resource – and its role as a demonstrator. The charger and the software are enabling (digital and future V2G-ready) infrastructure whose benefits are not quantified as energy savings. Measured cost savings for the first weeks of operation amount to approx. **EUR 92** (698.9 kWh × 0.131 EUR/kWh up to 18.06.2026) [**M** energy × **E** price].

The **reduction of about 25 % in annual electricity-related costs** mentioned in Version 1 and in D.2.3.1 originates from the feasibility study (2024) for a larger PV plant (17.7 kW) combined with storage and peak-power reduction. It is a **feasibility-stage estimate** that has **not** been confirmed by measurement for the as-built system (11.7 kWp, no stationary battery, no V2G discharge) and is therefore not used as a result of this evaluation.

Reduction for a year round period will be available after a full year cycle, and until then some insight can be obtained from elapsed period given by Table 6 that shows monthly energy billed by HEP, compared to PV production recorded by SenzoriKA platform. Note that June production is not complete information as it was recorded only partially from the start of operation.

Table 6: Actual reduction percentage by month

Month (2026)	Measured PV production (kWh)	Monthly consumption (kWh)	Percentage of PV in relation to consumption (%)
June (from start of operation)	1,116.92	10,308.00	10.84
July	1,489.05	12,274.00	12.13
August	1,480.43	11,371.00	13.02
September	1,231.30	8,691.00	14.17
Total June - October 2026	**6,196.25**	**529.59**	

G. ENVIRONMENTAL EVALUATION

The environmental evaluation follows the MRV methodology (D.2.4.3) with the Croatian factors: CO_2 emission factor for electricity 0.159 kg CO_2/kWh, primary energy factor for electricity 1.498, CO_2 emission factor for petrol 0.280 kg CO_2/kWh and primary energy factor for petrol 1.130. The annual values in Tables 6 and 7 are **calculated** on the basis of design parameters **[C]**.

PV plant measured result to date: the **6,196.25 kWh** of PV electricity produced up to 30.10.2026 **[M]** correspond to approx. **985 kg CO_2** avoided and approx. **9,282.00 kWh** of primary energy saved (factor 0.159 kg CO_2/kWh and 1.498 primary electricity factor). For these first few months of operation, about half of calculated amounts by Table 8 were achieved. This was done within the most sunny days so any conclusion should await completion of full year cycle that will reveal more precise information to compare against initial calculation given by Table 8. However, assuming a typical monthly distribution for continental Croatia, and taking the collected data into account, calculated amounts in Table 8 have a great chance of achieving.

Table 7: PV plant - calculated annual energy, CO_2 and cost savings (MRV, D.2.4.3) [C]

Parameter	Value	Unit
Rated (inverter) power	10.00	kW
Peak power (Ppv)	11.70	kWp
Module power / number of modules	450 / 26	Wp / -
Performance ratio (PR)	0.70	-
Full-load hours at 1000 W/m²	1,400	h
Share of electricity fed into the public grid	0.00	-
Lifetime / discounting factor	23 / 15.45	years / -
Electricity unit cost	0.131	EUR/kWh
Investment (actual, excl. VAT)	15,247.67	EUR
Final energy savings (FES)	**11,466.00**	kWh/y
CO_2 emission savings	**1.82**	t CO_2/y
Primary energy savings	**17,176.07**	kWh/y
Cumulative energy savings (lifetime, discounted)	177,161.17	kWh
Cost savings	1,502.05	EUR/y
Simple payback period	10.15	years

Electric vehicle measured result to date: **5,338 km** travelled correspond to approx **877 kg CO_2** avoided and approx **3,021 kWh** of primary energy saved (factor 0.280 kg CO_2/kWh and 1.13 primary petrol factor). As the vehicle is in use since the end of February, initial calculated values in Table 9 might turn to be a slight overestimate. Final conclusion should await completion of full year cycle that will reveal refined information.

Table 8: Electric vehicle – calculated annual energy, CO_2 and cost savings (MRV, D.2.4.3) [C]

Parameter	Value	Unit
Old vehicle: petrol passenger car, 7.5 l/100 km × 9.35 kWh/l	0.70125	kWh/km
New vehicle: battery-electric passenger car	0.199	kWh/km
Annual mileage / number of replaced vehicles	12,650 / 1	km / -
Final energy savings (FES)	**6,353**	kWh/y
Lifetime / discounting factor	8 / 7.002	years / -
Cumulative energy savings	44,487	kWh
Petrol savings	680	l/y
Primary energy savings	**7,179.41**	kWh/y
CO_2 emission reduction	**2.08**	t CO_2/y
Petrol unit cost	1.64	EUR/l
Cost savings	1,114.40	EUR/y
Investment (actual, excl. VAT)	33,500.00	EUR
Simple payback period	30.06	years

In total, the pilot is calculated to save approx. **17,800 kWh of final energy**, **24,400 kWh of primary energy** and **3.9 t CO_2 per year** (PV 1.82 t + EV 2.08 t) **[C]**. In addition, the feasibility study estimated that the integrated use of PV and the EV as storage reduces the building's carbon footprint from 18.6 t to 15.9 t CO_2 per year and its maximum 15-minute power from 50 kW to 36 kW **[E]**; these effects depend on V2G-type discharge and are not achieved by the as-built system.

H. DEVIATIONS FROM THE ORIGINAL INVESTMENT CONCEPT

Table 9: Deviations from the original investment concept

Element	Original concept	As implemented	Reason	Effect on results
Storage	Stationary battery	No stationary battery; EV as mobile storage	No fire-safe room in the heritage building; fire-protection fit-out almost triples battery cost (feasibility study, 2024)	Storage availability depends on vehicle use; additional transport function
EV function	V2G	V2L	No V2G-capable vehicle on the market; V2G regulation in development; modification approved 31.10.2025	No discharge through charger or into the grid; local supply of small loads only
Charger operation	Bidirectional V2X operation	Bidirectional-ready charger used for charging	As above	Future-proof; V2G possible later without new works
PV plant	Up to 20 kWp (AF); 17.7 kW technical potential	11.7 kWp, red modules, non-visible roof surfaces	Heritage-protection and fire-protection requirements; design amended 02.–05.2026	Lower generation than technical potential; design yield 13,964 kWh/y
Energy management	Optimising EMS controlling supply, demand and storage	Monitoring, metering, alarms and public visualisation	No dispatchable storage (no V2G, no battery)	Results quantified by monitoring; automatic peak shaving not demonstrated
Timeline	Completion 2025	Completed 03.06.2026	Repeated procurements, contract termination, design amendment	Shorter monitoring period within the project

I. LESSONS LEARNED

- **Verify market readiness before procurement.** V2G was technically feasible in the study, but no V2G-enabled vehicle could be purchased in Croatia. Technical specifications for innovative technologies should be checked with manufacturers and importers (including software unlocking per country) before tendering.
- **Stationary storage in heritage buildings is constrained by fire safety.** Space and fire-protection requirements can make a stationary battery uneconomic; using an electric vehicle as storage is a practical alternative, but its availability is limited by its mobility function.
- **Coordinate heritage and fire-protection authorities early and in writing.** Requirements that were accepted during design (standard modules) changed during implementation (red modules, new fire-protection rules) and caused a contract termination, a repeated procurement, a design amendment and about six months of delay.
- **Keep the system modular and future-proof.** Installing a bidirectional charger allows V2G to be activated later without new works, even though the first vehicle supports only V2L.
- **Plan monitoring from the start.** Integrating the building main meter and the DSO export meter in the EMS is needed to measure self-consumption and peak reduction directly; otherwise these effects remain estimates.
- **Allow time contingencies in contracts.** Contract annexes and addenda (PV Annexes 1–2, software Addenda 1–2) were needed because components depend on each other (the software could only be finalised after the PV installation).

J. TRANSFERABILITY AND REPLICABILITY

The Karlovac solution uses standard, commercially available components (PV modules and inverter, AC charger, electric vehicle, monitoring platform) and can be replicated in other public buildings, particularly small and medium-sized buildings in historic city cores where conservation requirements limit conventional retrofit measures. The modular configuration allows phased implementation by municipalities with limited budgets.

The main conditions for replication are: early agreement with the conservation and fire-protection authorities on the type, colour and position of PV modules; DSO approval for bidirectional connection; and a realistic assessment of V2G availability. Until V2G-enabled vehicles and the related regulation are available, replication will rely on V2L or smart unidirectional charging; the bidirectional-ready charger enables a later upgrade. The experience, the chronology (D.2.3.2) and the MRV-based evaluation were shared within the ZEB4ZEN partnership (Palmanova and Zamość pilots) and support the transferability of the approach to other Central European historic districts.

K. CONCLUSIONS

The commissioned Karlovac pilot consists of an 11.7 kWp rooftop PV plant with roof-coloured modules, a bidirectional (V2G-ready) charging station, an electric vehicle with V2L function used as a mobile energy resource, and a monitoring and energy management platform with a public display. All components were handed over between 19 December 2025 and 3 June 2026, and the integrated system has been in operation since June 2026.

Measured data confirm that the PV plant operates as designed (6,196.25 kWh produced by 30 October 2026, approx. 50–55 kWh per day in mid-June, peak output ≈ 9 kW), that EV charging is metered by the EMS, and that the V2L function works. Calculated annual savings according to the MRV methodology are approx. 17,800 kWh of final energy, 3.9 t CO_2 and EUR 2,600; these remain estimates until a full year of measurements is available. First few months of operation until 30 October 2026 suggest real world savings will come close to calculated (8,870 kWh of final energy, 1.8 t CO2 and EUR 1,467). This depends on total vehicle usage and also on actual monthly distribution for continental Croatia in the full year cycle ahead.

Compared with the original concept, the stationary battery was replaced by the electric vehicle and V2G by V2L, so energy cannot be discharged from the vehicle through the charger and automatic peak shaving is not demonstrated. The feasibility-stage estimate of a 25 % reduction in electricity costs is therefore not confirmed for the as-built system. Despite these limitations, the pilot demonstrates how renewable generation, electric mobility and digital monitoring can be integrated in a heritage-protected public building, and it provides concrete lessons and a future-proof (V2G-ready) infrastructure for replication.