



W H I T E P A P E R

Vehicle Preconditioning in Electric Bus Depot Operations

How integrated VDV 261 implementation delivers operational efficiency across the depot ecosystem.

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Executive Summary

Electric bus fleets face a coordination challenge beyond charging, involving two energy-intensive processes: battery preconditioning and cabin conditioning. These must be completed before departure using grid power instead of traction battery energy. Executing this reliably at scale across mixed-vendor depots requires system-level integration.

VDV 261 is the protocol that enables vehicles and depot backends to exchange the data needed for this coordination. Efficient preconditioning depends on how the Charge Management System (CMS) interprets and acts on that data: whether it integrates preconditioning into smart charging optimization, handles variability between vehicle OEMs and charger vendors, and connects to the operational systems—scheduling, depot management, energy—that impact operational decisions.

This whitepaper explains how VDV 261 works, where the integration challenges lie, and what operators should evaluate when assessing CMS capability in this area.

1. Why Preconditioning Matters

An electric bus is not operationally ready simply because its battery is charged. Before departure, two further processes must be completed:

- **Battery preconditioning:** bringing the battery to an optimal temperature for peak efficiency and long-term longevity.
- **Cabin preconditioning:** heating or cooling the interior to passenger-ready conditions.

Both processes consume significant energy. If they happen after the vehicle leaves the depot, they draw directly from the traction battery and reduce the available route range. If they occur while the vehicle is still connected to the grid, they use external power instead, preserving battery capacity for driving.

The operational imperative is that preconditioning must finish before departure, powered by the grid, and timed precisely so the vehicle is ready when needed without wasting energy through premature or prolonged conditioning.

Without coordinated preconditioning, operators face a trade-off: start early and waste energy, or start late and risk delays. System-level integration eliminates this trade-off.

2. The Role of VDV 261

The VDV 261 protocol defines how an electric vehicle and the depot backend exchange the data needed to coordinate preconditioning. It enables the vehicle to communicate its requirements — the time and energy needed for both battery and HVAC preconditioning — so the CMS can plan and respond accordingly.

2.1 The Communication Path

A common misconception is that VDV 261 operates as a direct interface between the vehicle and the backend system. In practice, communication always travels through the charger:

Vehicle ⇄ Charger ⇄ CMS

This routing has significant implications. Each layer in the chain carries its own requirements, and a failure at any layer breaks the end-to-end flow.

- **Vehicle:** must expose preconditioning parameters (battery and HVAC time and energy requirements) and identification metadata (VIN, EVCCID) via VDV 261, implemented as part of ISO 15118 Value Added Services (VAS).
- **Charger:** must implement ISO 15118 VAS, terminate the TLS session on the vehicle side, and forward the VAS payload to the CMS over HTTPS. The charger acts as an external gateway to the internet for the vehicle.
- **Network layer:** VDV 261 mandates IPv6 end-to-end. Since most operator backends remain IPv4-only, the charger typically needs to run NAT64/DNS64 or an IPv6⇌IPv4 proxy to reach the CMS.
- **CMS:** must interpret the vehicle's request, compute and optimise a charging plan against fleet priorities, and respond in real time while also managing the ISO 15118 PKI, including automated renewal of EVSE TLS certificates whose lifetimes are shortening from 398 days toward 200, 100, and ultimately 47 days.

2.2 What the Vehicle Communicates

VDV 261 is not just a “start preconditioning” trigger. It is a structured, continuous data exchange every 10 seconds, creating a real-time control loop.

The vehicle sends:

- Required battery preconditioning energy and duration
- Required HVAC preconditioning energy and duration

The CMS responds with:

- The departure time
- The requested preconditioning mode (heating, cooling, or ventilation)
- Whether preconditioning is required at all
- Current ambient temperature

This continuous loop allows the system to adapt to changing conditions such as a vehicle connecting later than expected, an updated departure time, or a shift in ambient temperature. It avoids executing a fixed pre-programmed schedule.

2.3 Interoperability in Multi-Vendor Environments

In multi-vendor environments, systems can be fully standards-compliant and still fail to interoperate reliably. VDV 261, like OCPP, leaves room for interpretation: retry behaviour, SNA handling, energy-versus-deadline conflicts, reconnect semantics. Two fully compliant implementations can still fail to interoperate.

Making VDV 261 work reliably end-to-end requires the vehicle, charger, and CMS to agree on the unspecified cases, not just the specified ones. Validating that alignment across the range of vehicle OEMs and charger vendors found in real depot environments is where a mature CMS earns its keep.

3. What Good Implementation Looks Like

VDV 261 creates the communication channel. The CMS determines how the information is used. The quality of implementation and its operational impact depend on four areas.

3.1 Protocol Mediation Across Heterogeneous Hardware

A depot running multiple vehicle OEMs and charger vendors cannot assume consistent behaviour from any of them. A CMS that handles VDV 261 effectively must:

- Integrate with chargers via OCPP (1.6 and 2.0.1) for session management, power control, metering, and smart charging while running the VDV 261 / V2ICP channel as a separate HTTPS pipe alongside it
- Normalise VDV 261 payloads across vendor implementations, handling differences in field usage, sequence behaviour, and SNA handling
- Manage ISO 15118 VAS requirements, including automated renewal of EVSE TLS certificates as certificate lifetimes shorten
- Provide genuine protocol-level diagnostic capability: able to read the actual ISO 15118 / V2ICP exchange when integration issues arise, rather than treating every problem as a vendor escalation

The result is that operators are not locked into a single OEM or hardware vendor, and onboarding a new vehicle or charger model does not become a months-long integration project.

3.2 Integration with Smart Charging Optimisation

Preconditioning must not be scheduled in isolation. It is part of a unified optimisation schedule including load balancing and peak demand management. A CMS that treats preconditioning separately from charging will produce suboptimal plans that satisfy one constraint while violating another.

Effective implementation combines VDV 261 inputs with grid constraints, tariff windows, fleet-wide power allocation, and departure deadlines to optimize charging and preconditioning against fleet priorities, for example:

- When to start preconditioning each vehicle
- How to sequence it relative to active charging
- How to distribute available power across the fleet without breaching peak limits

3.3 Alignment with Operational Systems

VDV 261 only becomes operationally valuable when the CMS is connected to the systems that manage depot operations. Static configuration is insufficient; preconditioning plans must reflect live data.

The relevant integrations include:

- **ITCS and scheduling suites** (including IVU.suite, Init MOBILE, Trapeze ITS, and Hastus): timetables, vehicle blocks, and departure times.
- **Depot Management Systems (DMS)**: vehicle assignments, yard positions, and availability.
- **Energy Management Systems (EMS)**: grid constraints, dynamic tariffs, and demand response signals.

A same-day schedule change should propagate to the charging and preconditioning plan automatically, not at the next overnight batch cycle.

3.4 Real-Time Control Loop

Because VDV 261 messages are exchanged every 10 seconds, the system can operate as a genuine feedback loop rather than a one-time plan:

1. The vehicle sends updated conditions.
2. The CMS recalculates the optimal charging and preconditioning plan.
3. Updated instructions are sent back to the vehicle.

This enables dynamic adaptation: a vehicle connecting later than expected, an updated departure time from the ITCS, or a constraint change from the EMS can all be absorbed without manual intervention.

4. Evaluating CMS Capability: The Right Questions

For procurement and IT decision-makers, the question is not “does the CMS support VDV 261?” — every vendor will say yes. The real questions are about the layers that make VDV 261 work in practice.

End-to-End Charging Control

- Does the system processing VDV 261 also run the smart-charging plan over OCPP, or are these separate systems reconciled afterward?
- Are preconditioning energy requirements and deadlines inputs to the optimisation, or are they constraints applied afterward?
- Does the plan honor peak limits, tariff windows, and grid constraints while meeting every vehicle’s preconditioning deadline?

Vehicle OEM Variability

- How does the CMS handle what the specification leaves undefined: SNA values, retry behavior, reconnect semantics, and energy-versus-deadline conflicts?
- Is that behaviour documented per OEM, or hand-tuned site by site?

System Integration Depth

- Which DMS, ITCS, and scheduling suites are integrated in production, and over VDV 463 or a vendor-specific API?
- Does a same-day schedule change propagate to the charging plan automatically, or does it wait for the next overnight cycle?

Failure Handling

- How and when does dispatch learn that a vehicle will not be preconditioned in time, at pull-out or early enough to act?
- What is the fallback behavior when the VDV 261 channel fails mid-session?

5. How Tenix Addresses These Requirements

Tenix Charge embeds VDV 261 within a broader architecture that connects vehicles, chargers, and operational systems into a unified control environment. The design reflects the constraints of real multi-vendor depots, not only single-vendor environments.

On protocol mediation, Tenix Charge integrates OCPP 1.6 and 2.0.1 for charging session control alongside the VDV 261 / V2ICP channel. It normalises payloads across vehicle and charger vendor implementations, automates EVSE TLS certificate renewal, and provides protocol-layer diagnostic capability when integration issues arise.

On optimisation, preconditioning is not scheduled independently. It is part of the unified plan that manages load balancing, peak shaving, and fleet-wide power allocation, using VDV 261 inputs as live constraints rather than post-hoc adjustments.

On operational integration, Tenix Charge connects with ITCS and scheduling suites (IVU.suite, Init MOBILE, Trapeze ITS, Hastus), Depot Management Systems, and Energy Management Systems over VDV 463 and vendor-specific APIs. Same-day schedule changes propagate automatically to the active plan.

The result is a system in which VDV 261 delivers value through reliable interoperability and operational integration across the entire depot ecosystem.

Conclusion

The VDV 261 protocol creates the communication channel for preconditioning, but it is the CMS that decides what is done with it. As electric bus fleets scale, inefficiencies in preconditioning compound, affecting range, energy cost, and operational reliability.

When preconditioning is fully integrated into charging optimisation, connected to live operational data, and validated across hardware combinations in real depots, VDV 261 delivers on its promise. When treated as a standalone integration tick-box, it may not.

For operators evaluating a Charge Management System, the differentiator is not the protocol itself. It is the demonstrated ability to operationalise it across the entire depot ecosystem.

To discuss VDV 261 integration requirements or request a technical briefing, contact Tenix at tenix.eu.