

PSIebus

# Depot and Charging Management for Electric Buses

PSI 

# Our Vision: Zero Emission

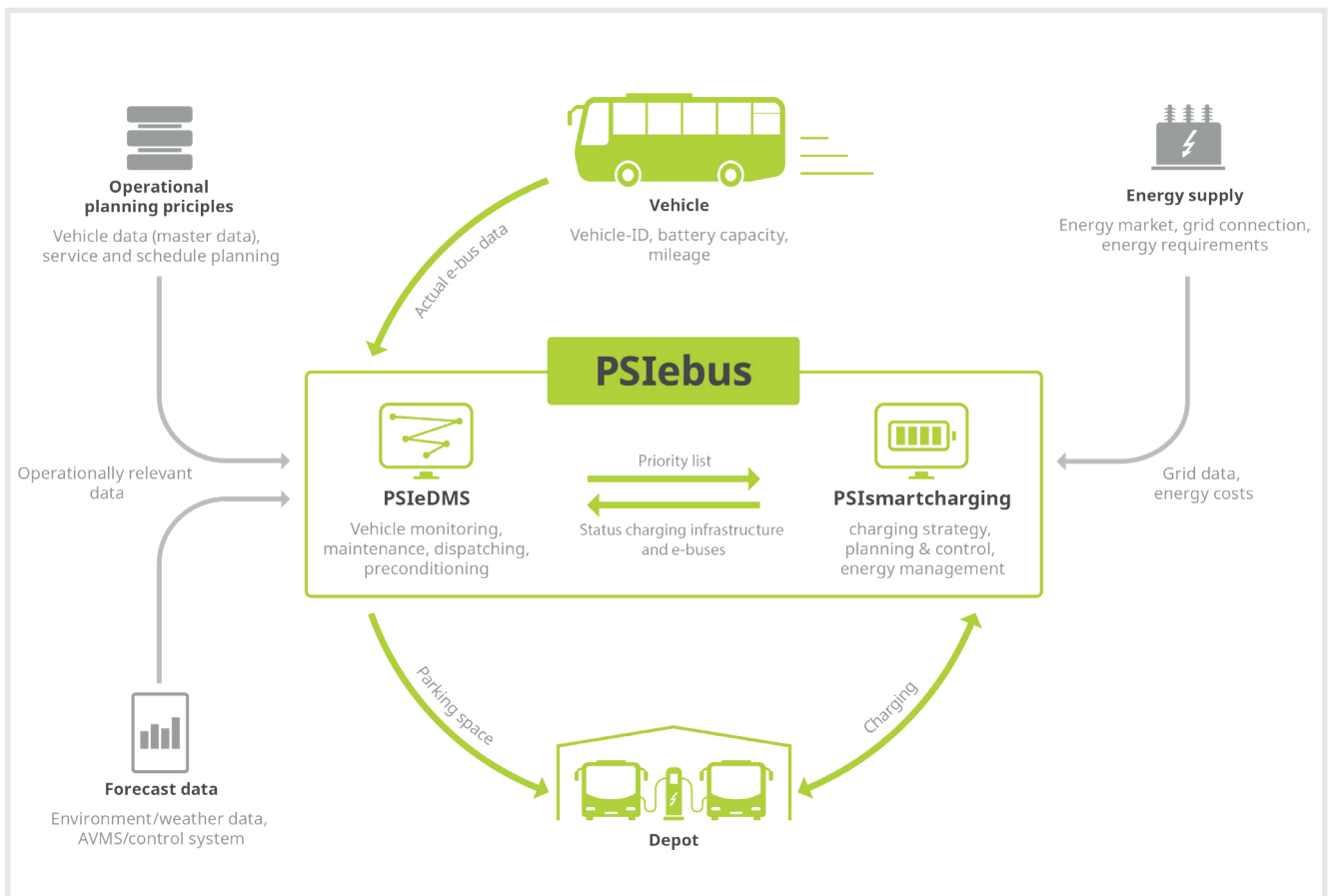
## The Integral Depot and Charging Management System for e-Bus Fleets

Emissions-free local and long-distance transport has become the expressed goal of many municipalities and cities. Besides light rail, electric buses are also gaining in importance. The ever-increasing number of new vehicles is not only altering city streetscapes, but converting to electromobility is also having a dramatic impact on operational processes. This requires the deployment of new systems at depots.

Next to changing demands on employee qualifications as well as service and maintenance technologies, dispatching systems also need to be adapted. New factors such as limited battery ranges, charging infrastructures along routes or at the depot, ridership numbers, outside temperatures and power supply capacities will be key to reliable public transit operations of the future.

PSIebus offers transport companies an integral software solution that combines expertise in both public transit processes and energy supply. The system merges the depot management module PSIDMS with the charging management system PSISmartcharging. It takes into account required factors and dependencies relevant for efficiently controlling, charging and dispatching vehicles – both at the depot and along the route. Its modular system architecture and open interfaces make it scalable and future-proof. The system also uses standardized interfaces for data exchange, making it manufacturer-independent. Deploying the total PSIebus solution ensures a fast, reliable and secure switch to new decarbonized propulsion technologies.

## PSIebus Integrates All Tasks Associated with Electromobility in One System





# PSIeDMS

## Vehicle Monitoring and Control 24/7

Energy consumption during operation varies due to a multitude of factors, such as the number of riders, the outside temperature, the route profile, and driving behaviour. Additional factors include unique characteristics of vehicles, such as the manufacturer, and the process of battery aging. As a result, the charge level and the remaining vehicle range change minute-by-minute. Live monitoring is therefore an indispensable necessity for reliable operations processes. Vehicle master data and all variable vehicle and environmental data from daily operations are collected by PSIeDMS, forming the basis for forecast calculations and charging schedules. Preconditioning the e-buses is started just in time, so that all vehicles are sufficiently charged and have achieved operating temperature by the time the route begins.

### Overview of Functions

- + Vehicle Monitoring During Ongoing Operations**

PSIeDMS is continuously updated on the status of your vehicles while they're in route and at the depot. It receives data from the AVMS, CAD, AVL system or directly via data loggers from the e-bus. That's how battery capacity, mileage and energy consumption are monitored online.
- + Charging Process Control and Automatic Vehicle Dispatching**

When charging begins, each charging process is assigned a priority that depends on the planned vehicle use. Based on this priority, charging processes throughout the entire depot are balanced without overloading the transformers or the grid connection. While charging, the charge levels are continuously recorded in PSIeDMS and compared with the energy requirements of the planned route. After the vehicles are sufficiently charged, the system switches to maintenance charging. If for any reason the route energy demand cannot be met, a new priority is given, or other vehicles are assigned – automatically. Preconditioning starts just in time based on the route start time. All depot processes, such as maintenance, cleaning and repair, are taken into account while charging.
- + AI-Based Forecasting of Ranges, Energy Consumption and Energy Demand**

PSIeDMS uses the Deep Qualicision™ optimization algorithm based on Artificial Intelligence (AI) to forecast ranges, energy consumption and energy demand.
- + Parking Space and Charging Station Allocation**

When a bus enters the depot, PSIeDMS in a few seconds identifies the parking space with the correct charging station – based on the battery's charge level and the vehicle's next route. If no charging is required, the vehicle can also be assigned to a parking space without any infrastructure, meaning that not all parking spaces have to be equipped with charging technology.
- + Preconditioning**

Preconditioning vehicles is automatically performed before the route begins and in a timely manner. This ensures that trips start on time and that batteries are not subjected to unnecessary stress.





# PSISmartcharging

## Dynamic Load and Charging Management

PSISmartcharging communicates directly with PSIEdms to ensure that electric buses are charged to the optimal level and on time for their intended routes, while also considering safety aspects. All electrical systems in the depot (feed points, transformers, lines, charging stations) are permanently monitored. In the event of imminent overload or limits to the energy supply, the power is redistributed to restabilize the grid. It is possible to integrate additional battery storage or photovoltaic systems at the depot to increase flexibility.

Electricity price fluctuations can be flexibly taken into account during scheduled charging. In the future, it will also be possible to generate ancillary revenues – where the corresponding technology is available – by offering control power.

### Overview of Functions

- + Planning the Charging Process**  
PSISmartcharging creates a charging plan that takes into account the prioritization of the charging processes in PSIEdms and the limitations of the grid connection capacity and the electrical system at the depot.
- + Charging Process Control and Maintenance Charging**  
The system controls charging processes based on the prioritization of e-buses and the currently available grid connection capacity. The limits of the electrical system in the depot are also considered. To compensate for self-discharge, cyclical charging processes are automatically monitored and controlled.
- + Monitoring the Electrical System in the Depot**  
The current status of the electrical system at the depot is graphically displayed in real-time.  
In this way, malfunctions can be detected, analyzed and immediately remediated.
- + Optimizing the Energy Supply**  
The local power grid and the equipment connected to the grid are cyclically and automatically monitored by the system and displayed in network diagrams. In case of malfunctions, threshold violations or alarms, the electrical control system is notified.
- + Support of a Grid-Friendly Operation**  
Grid operators may, in special cases or based on grid connection usage contracts, reduce the available grid connection capacity in order to compensate for an imbalance in electricity generation and consumption in the distribution grid. The system receives the grid operator's service specification, calculates the available charging capacity, and takes this into account when creating new charging schedules.

# Rethinking Mobility – With PSIebus

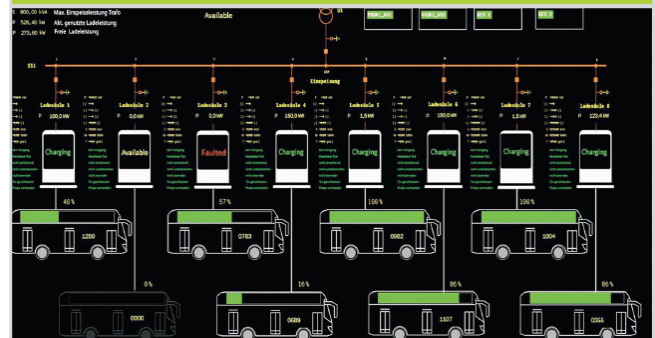
## PSIeDMS



### Vehicle Monitoring and Route Allocation

- + AI-based range forecast
- + 100% availability of vehicles in daily operations
- + Automatic dispatching of parking spaces and routes
- + Administration and control of different bus manufacturers in one system
- + VDV 461: Fleet management system interface (AVMS, CAD-AVL, YMS)
- + VDV 463: Charging management interface
- + Interface to weather data
- + Consideration of all depot processes (cleaning, shop, ...) while charging
- + All functions also available for diesel, gas or hydrogen buses

## PSIsmartcharging



### Grid Monitoring, Grid Control, Scheduled Charging

- + Monitoring of all voltage levels
- + Limits during bottlenecks
- + Automated switchover in case of errors
- + KRITIS-certified power supply components
- + Control of different manufacturers' charging stations in one system
- + Fast reaction time in case of errors and downtimes
- + Support for emergency operations
- + Performance monitoring
- + On-demand and grid-friendly charging
- + Connection to existing grid control rooms



### Your benefits with PSIebus

- + A comprehensive solution for vehicle dispatching and charging management
- + from a single source through modular architecture
- + 100% vehicle availability in daily operations
- + Grid fee savings through smart grid operation and grid-friendly charging
- + Reduction and optimized utilization of the charging infrastructure
- + Manufacturer independence through support of diverse charging stations and buses
- + Optimization through many degrees of freedom
- + System operations in the cloud
- + Support for vehicle-to-grid in the future



# Project Reference: Hamburger Hochbahn AG

As part of its introduction of emissions-free buses in April 2019, the Hamburger Hochbahn opened the first bus depot in Germany completely designed to support e-mobility. It provides the required charging technology and energy supply for 240 e-buses.

The depot management system PSITraffic/DMS was expanded for this purpose, adding a module for charging and load management of the buses, as well as functions important for vehicle management.

In the future, it will control the processes in the e-bus depots throughout the city. Until the switch to e-bus operations has been completed, it will ensure that the required number of diesel and electric buses in parallel operation are available for refuelling or charging, also dispatching drivers while considering their duty rosters.

The dispatching core used for this is based on PSI's own optimization software Deep Qualicision™, which finds solutions in seconds based on operational conditions. The PSIE-DMS automatically checks which vehicles at the depot will best match which open routes after how many minutes of charging. This means that not all electric vehicles must be charged simultaneously, constantly or completely.

The PSISmartcharging management system controls the entire energy requirement and monitors and controls the charging performance of individual chargers.

This reduces costs during power grid expansion and guarantees stable e-bus operations. The system is also designed for the potential mixed operation of electric and hydrogen-powered vehicles.





## PSI Transcom GmbH

Dircksenstraße 42-44  
10178 Berlin  
Germany

Phone: +49 30 2801-1610  
[info@psitranscom.de](mailto:info@psitranscom.de)  
[www.psitranscom.com](http://www.psitranscom.com)

