



CASE STUDY



1 | Challenge: **Contact wire-free, battery-powered on-board energy solution for optimizing routing in inner cities**

Citadis are low-floor tram vehicles from the French rail vehicle manufacturer Alstom. For years, these have been supplied with battery energy storage systems by HOPPECKE. A modular system and design enables Alstom to configure trams in different lengths according to the operator's requirements.

Cities face many challenges when planning trams: Route restrictions such as underpasses or narrow streets have to be overcome. The cityscape, especially historic areas, landmarks and city centers, is disfigured by overhead lines and poles.

While standardised technical components are used in the construction of the trams, the design and interior design of the vehicles can be carried out according to the operator's individual specifications. This makes it possible to create a direct link to the city and to give the tram the identity of the city. Therefore, a special feature in the tram sector is that individual operator projects are comparatively small.

In many projects often only a few number of ten to 20, in exceptional cases up to 50 trams are ordered. With Citadis Alstom offers various vehicles in different lengths which differ in terms of the number of individual cars. At the same time the weight of the components plays a major role. Since a tram is significantly lighter than other types of trains, it is necessary to find an optimum compromise between weight and energy.

In order to keep costs down even for small projects, modularity plays a particularly important role. The goal for HOPPECKE is to create a cross-project, modular solution for both the tram vehicles and their components.

Cost optimisation
especially for
small projects

Routing
in the urban
environment

Disfigurement
of the cityscape
by overhead lines

Compromise
between
weight and energy



"The modularity of the battery system gives our customer the ability to order the same system with different options for different projects at any time."

Hans-Peter Czernietzki
HOPPECKE Rail

Flexibility
modular
battery system

Technology
suitable
battery technology

Aesthetics
retention of
the cityscape

Comfort
smart energy
management

2 | Solution: Cost-optimised energy supply through modular battery system

With the development of a technology-independent, modular battery system, HOPPECKE offers a rail on-board energy solution tailored to the different challenges of tram operators.

Based on these requirements, HOPPECKE has developed a modular, technology-independent battery system for his customer Alstom. Depending on the length of the trams, different battery capacities can be used in the same battery container. This offers Alstom the possibility of ordering the same system with different options for different tram projects at any time. At the same time, the container roof can be equipped with a "sun shield" and thus optimally adapts to the requirements of cities in tropical regions.

The battery system which was developed for Citadis trams consists of a two-part container that is installed on the roof of the tram. Depending on the capacity, 19 to 40 nickel-cadmium battery cells and a temperature sensor are installed in one container section.

The electrical components are installed in the other, much smaller part of the container. Here, HOPPECKE was able to score points with its many years of electrical expertise as an energy expert and convince the customer of its merits. This part of the battery system, which is used for electrical protection and for connecting the power and control cables, has a much more complex design. Unlike many other battery systems, a redundant fuse system is used, using a special fuse switch that comes from the military sector.

Thanks to the fully integrated and intelligent on-board battery system, the tram can run without overhead lines for the entire journey. It is automatically recharged at stops during passenger changes - with absolute safety. Energy is stored on board, ensuring the tram's range between two charging points.

This means that cities can now preserve their historical heritage and the aesthetics of the urban environment by dispensing with disruptive overhead lines. Therefore, the space requirement is reduced for trams and offers cities more freedom in planning the routing. Narrow streets, underpasses or complex adaptations to the surroundings can be successfully managed.

Key Benefits

- Cost optimisation due to modular battery system
- Recharging during passenger changes at stops
- Full energy recovery in braking mode
- Energy management during route obstruction to avoid power loss
- Preservation of the aesthetics of the urban environment
- Reduced space requirements compared to routes with overhead contact lines
- Freedom of routing in the urban environment
- Coping with route restrictions like narrow streets or subways

3 | Products :

- ▶ Nickel-cadmium batteries (FNC, Sinter) as auxiliary/ emergency power batteries
- ▶ Full-service contracts for lifetime optimisation
- ▶ Real-time online monitoring portal
- ▶ Individual consulting for optimal battery utilisation



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