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## Tramways cut the cord



Ground-level power supply

### Network

*It is common knowledge that tramways have not only made a successful, high-profile return to our city streets, but are continuing their advance and winning over new converts. Although, of course, this is due to the intrinsic qualities of tramway as a public transport mode, it is also now because tramway is starting to free itself from the confines of its overhead lines.*

This situation is prompting operators to prepare as best they can to cope with innovation and the habitual difficulties posed in terms of fine-tuning.

#### Tramways make inroads

The multiple benefits of the tramway are underpinning its steady advance throughout our cities.

During this era of a marked shift away from individual towards collective forms of transport, **efficiency** in terms of capacity (on average 8,000 passengers per hour and per direction) is a necessity more than ever. In town, the tramway's **visibility** acknowledges its social status and user-friendliness. Moreover, tramway's use of **electrical energy** is a point in its favour, and an area where real progress promises to be made. Further-

more, at a time when excess consumption of space is frowned upon, the tramway is spearheading the move towards optimised use of urban surface space. After "no parking, no business" in town, we now have "no tramway, no centre".

As everyone knows, commercial speed is a major asset, yet a constant battle. Increasing speeds from 15km/h to 17 km/h, or even to 19 km/h, is equivalent to 15%, even 30%, of extra capacity (at same cost) for the system with the same amount of extra appeal in terms of revenue: in short, an Eldorado. **Tram priority** thus plays a major role in terms of both frequency and speed.

**Urban planning** officials understood immediately that the tramway was a tool that could give a certain flair back to our city centres. In a nutshell: trams and cities are made for one another.

*I love this quote from one of my mentors in Zurich: "Trams do not need many green lights... they just need the lights to turn green when they reach them."*

Blessed with such assets, it is reasonable to expect trams to continue their advance yet further. Nonetheless, trams do prompt a degree of reticence, particularly in cities with no tramway that fear the visual impact of overhead tram lines on their historical monuments. Hence the choice made by certain cities, Nice and Bordeaux for example, to opt for tramways without overhead power lines.

## Bordeaux, a Unesco world heritage site, has chosen a ground-level power supply

The Urban Community of Bordeaux, having launched an ambitious programme to complete three tramway lines simultaneously, has opted for a ground power supply (patented by Alstom) in the historic centre of the city in order to minimise the visual impact of the tramway.

The solution combines the transmission of electricity via overhead contact lines with a ground-level power supply. Ground-level power (cf. chart) consists of a power rail embedded in the permanent way and isolated from the road. This power rail is divided into sequences of blocks which only have power running through them when the tramway is positioned above them. Blocks then lose all power on the ground as soon as the tramway is preparing to exit the block having advanced to a position over the next block. Using this technique the tramway's current collectors continuously recover energy and leave a 'neutral' roadway ahead of and behind the tramway's path. Suitably insulated, the power line installed on the surface is constantly powered down and then powered up totally safely as convoys pass along it.

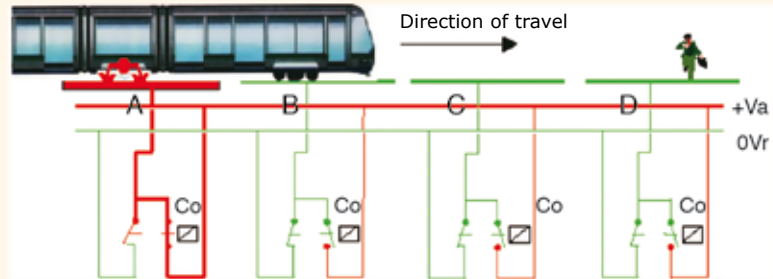
Switching between the two modes (ground power supply and catenary) is controlled from the driver's cabin when the vehicle is halted at a stop or station. The pantograph and collector shoe are then lowered at the point of transition between catenary section and non-catenary section and vice-versa. The bogie of each vehicle is fitted with two current collectors and two aerials.

This technology is being deployed along a total of 13.5km of twin track: 4.9km on line A (19.9km long), 6.1km on Line B (15.4km), and 2.5 km on Line C (8.0km).

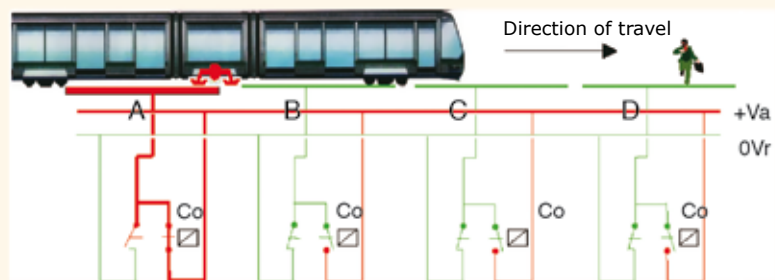
The cost of this system is derived from the addition of wayside and onboard components minus overhead line savings on the relevant track sections. According to the Bordeaux Urban Community authorities, despite ground-level power supply costing three times more per km than an overhead power line it should be underlined that the 'additional cost' of the ground power supply scheme in Bordeaux (13.5km of ground-level power supply over 44km of line) has been put at a mere 3% of the project cost.

Vehicles have had various modifications and also carry on-board batteries in case of power failures when passing over block sections.

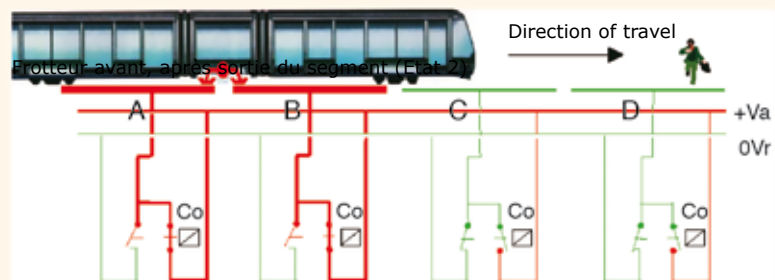
## Ground-level power supply



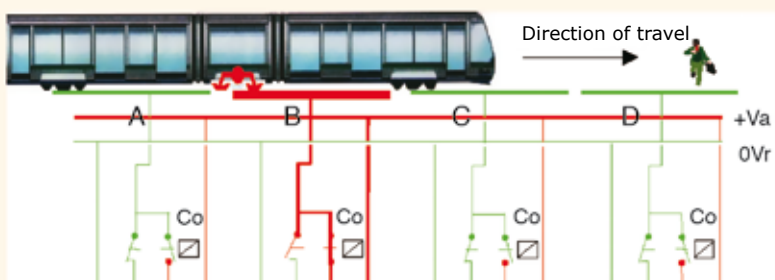
Initial stage (stage 1)



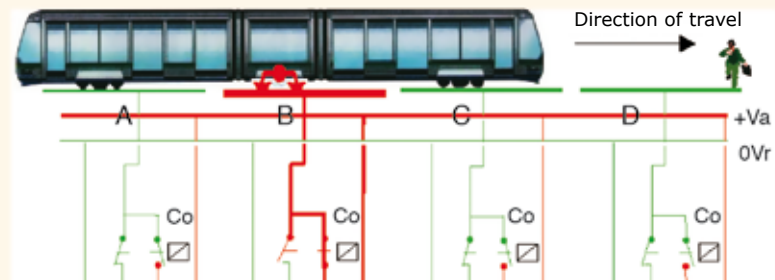
Forward collector shoe after leaving segment A (stage 2)



Forward collector shoe entering segment B (stage 3)



Rear collector shoe leaving segment A (stage 4)



Forward and rear collector shoes on segment B (stage 5)

Source: Revue Générale de Chemins de Fer, March 2008, pp.79-93

## Non-catenary tramway's first steps and operator know-how in the face of innovation

Innovation is driving operators headlong into the world of the unknown or, at any rate, one of fine-tuning. In the rail sphere, this 'high-risk necessity' requires at least 18 months of adjustments, with Bordeaux no exception to this rule. In effect, the difficult birth of ground-level power supply in Bordeaux produced an unavailability rate (see right) which, during the system's first six months, peaked at 12%. Faced with these technical difficulties and service interruptions (from 3.83 hrs / 10,000 km in 2004 down to 0.36 hrs in 2007 for ground-level power supply, and from 1.59 hrs down to 0.13 hrs over the same period for rolling stock) the operator turned to conventional replacement means by deploying temporary bus services, at least whenever disruption time exceeded acceptable limits for passengers. To reduce this unavailability rate, Veolia Transport also introduced an ongoing internal audit and strengthened its staff training programme.

Other improvements have been made to both the power supply system (e.g. replacing pre-mounted cable feeders with cables connected via 'submerged' casings, pilot line redundancy) and rolling stock. Though some solutions still need to be proven, the contractual availability level was reached two years in and has now been bettered.

### Conclusion

Faced with rising energy prices, which of course is affecting the public transport sector, we feel it necessary to prepare for even more innovation. This could involve supplying vehicles with power, storing and reproducing energy, or cutting energy consumption. As operators, we are putting our faith in industry to continue its research efforts and are willing to give these innovations our backing.

**Acknowledgements:** Alstom, Communauté Urbaine de Bordeaux, Veolia Transport Bordeaux, Communauté Nice Côte d'Azur, Veolia Transport Nice

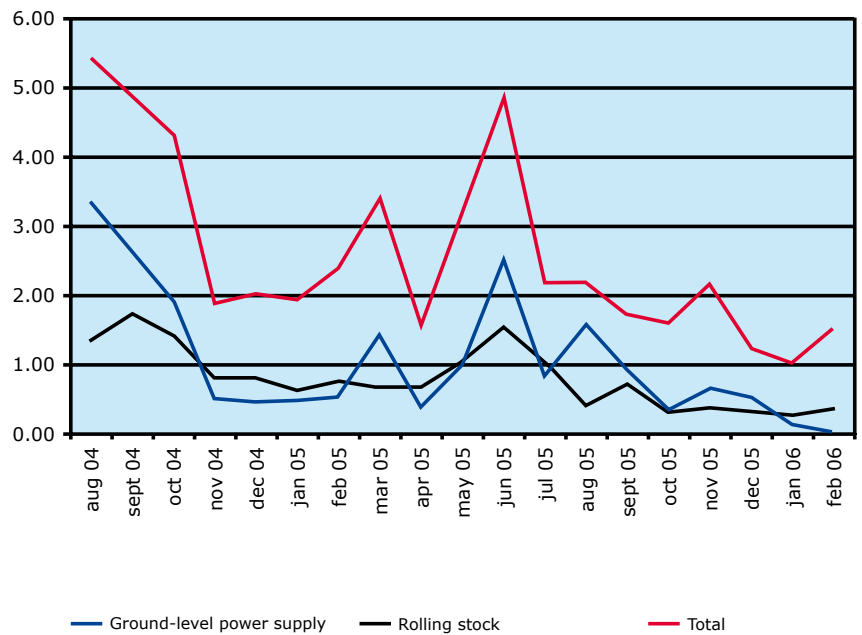
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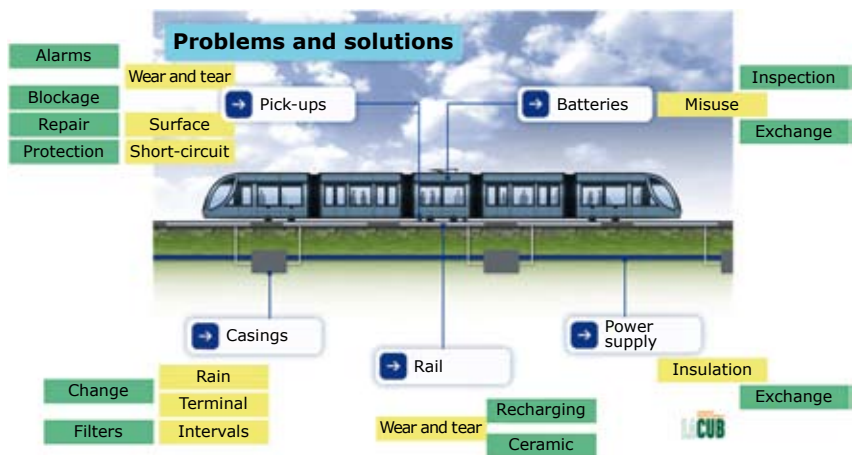
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Translated from the French original version

Service unavailability % from the 6th to the 24th month



**This chart shows the time required to perfect a system already in operation and will certainly stir memories for every city and operator to have experimented with its own innovation or its chaotic beginnings**



## Veolia Transport: 13 tramway and light rail networks

With 13 networks operating in seven countries (Germany, Australia, Spain, France, Ireland, Norway, Sweden) and a further two under construction (tram-train serving Lyon airport, Jerusalem light rail system), Veolia Transport operates tramways and light rail systems in diverse configurations. These range from large multi-line urban networks such as Bordeaux to interurban services around the outskirts of Berlin and from older, established networks like Saint Etienne to recent systems involving innovative urban projects (Barcelona, Nice).

The contractual formulas used are not only conventional operating contracts, but include franchise arrangements (design, construction and operation over very lengthy periods - 30 or 40 years), as in Rouen, Barcelona, Lyon and Jerusalem, or continue to encompass public-private partnerships, as at Görlitz in Germany, or very stringent demands in terms of service quality (Stockholm).

The technology deployed draws on innovation, e.g. Nancy's tram on tyres and the supply ground-level power or use of batteries on certain line sections (Bordeaux, Nice).

## Nice: battery instead of catenary

Line 1 in Nice supplies electricity to vehicles via catenaries. The two exceptions are the Masséna and Garibaldi squares, where tramway vehicles lower their pantographs and switch to battery power at the final stop before each of these historic squares, then perform the reverse process at the first stop after them. The batteries are charged by the catenary during the remainder of the trip.

The purpose of this operation has been to avoid installing unsightly electric cables alongside the magnificent buildings on these two squares and to allow carnival floats, whose dimensions would exceed the height of tramway overhead lines, an unimpeded passage during the Nice Carnival.

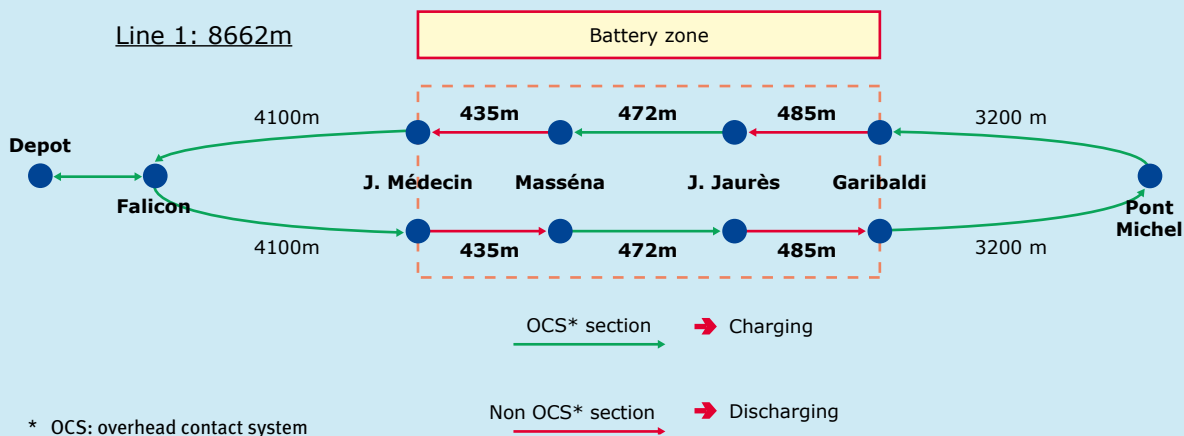
Implementation of this system, involving 0.9 km without overhead lines out of a total of 8.7 line km, has passed off without difficulty.



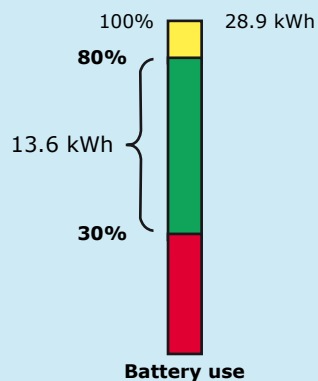
Photo: Caroline Bach, Courtesy Espace à Vendre

Top: This view of Nice's tramway against the backdrop of a church illustrates the unsightliness of overhead contact lines  
Bottom: Results have lived up to expectations

### Geometrical and energy constraints



This shows the ideal division between charge and discharge zones, making it possible to remain within the battery usage range conducive to a long working life.



In practice, batteries are used at between 33% and 80% of their capacity. The case study by Alstom of battery use, involving cases of nominal and impaired running, have made it possible to remain within this range and thus avoid zero-energy blockages, i.e. the most inconvenient type. At absolute total capacity of 28.9 kWh, energy consumption is 13.6 kWh.

## Overconfidence is innovation's worst enemy

Miryam Hernández Irigoyen, Junior Manager, Rail Division, Knowledge and Membership Services Department, UITP

No business can ignore innovation, but the challenge of implementing new technologies tends to be underestimated. Clients often specify contradictory requirements: designs need to be both proven and innovative!

To mitigate uncertainties linked to innovation and ensure a fair distribution of risks between manufacturers and operators, it is necessary to introduce and validate new technologies in a controlled and predictable manner, building in a specific commissioning process and planning enough time and expertise resources.

A joint working group of UITP Metro and Industry Committees issued specific recommendations in 2006, as part of the study Commissioning of new metro rolling stock. The lessons and recommendations retain their validity for other segment of our sector.

### Validation

Iterative validation is the core for success, starting with the technology itself, its implementation into the product and then the contractual arrangements.

Then, an homogeneous validation process has to be consistently applied along the supply chain, with operators in-

volvement, but more importantly with identical processes by system integrators and their sub-suppliers.

Validation should take place in real life conditions and with sufficient time.

### Software and obsolescence

With software life time much shorter than traditional sub-systems of the rail sector, special attention should be given to software and electronic components obsolescence. A working group is currently working on the issue.

The full study *Commissioning of new metro rolling stock* can be ordered from UITP ([publications@uitp.org](mailto:publications@uitp.org)). Note: The Light Rail Committee is currently undertaking the adaptation of this study to the light rail sector.

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