



**Innovative Technologies for Light Rail  
and Tram:  
A European reference resource**

**Briefing Paper 1  
Tyre Innovation -  
Rubber Tyre Trams  
September 2015**



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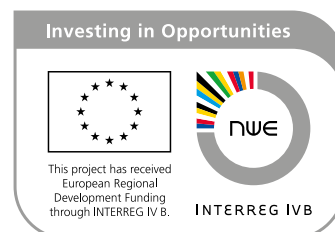


## Sustainable transport for North-West Europe's periphery

Sintropher is a five-year €23m transnational cooperation project with the aim of enhancing local and regional transport provision to, from and within five peripheral regions in North-West Europe.

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### INTERREG IVB



INTERREG IVB North-West Europe is a financial instrument of the European Union's Cohesion Policy. It funds projects which support transnational cooperation.



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## Background

This briefing paper is one of a series that together comprise a European reference resource for innovative technologies rail-based based systems, with particular reference to light rail and tram-based schemes in cities and regions. The approaches are also relevant, in many cases, to heavy rail and even other forms of public transport for example bus.

The resource is one of the Investments undertaken for the Sintropher project funded under the INTERREG IVB North West Europe Programme for transnational co-operation. The overall aim of Sintropher project is to develop sustainable, cost-effective solutions to improve connectivity to, from and within poorly connected regions in North-West Europe - to use innovative transport links to connect peripheral regions of NWE with the core European transport network of high-speed trains, via effective interchange hubs.

There has been a particular focus on tram-train systems which allow local trams to run on to national rail networks, pioneered in Germany, firstly in Karlsruhe and developed in Kassel, which allow urban tram systems to extend over national rail tracks to serve extensive city regions. The project has also looked at other innovative forms of tram systems such as single-track tramways, as well as high-quality transport interchanges that link such systems to major national or transnational rail or air hubs.

The project began in late 2009, with fourteen partner agencies in five EU Member States, and lead partner University College London (UCL): Valenciennes (France); the Fylde Coast (UK); West Flanders (Belgium); North Hesse (Germany); and Arnhem-Nijmegen (Netherlands). Participants included public transport operators, local authorities, regional transport agencies, and universities.

They have worked together on a series of feasibility evaluations, pilot investments and demonstration projects, as well as comparative analyses of EU best practice. The total budget is more than €23m, with funding part-financed by the EU's INTERREG IVB Programme.

A €1.5m project extension in 2014, covers follow-on work to capitalise on results from the initial project, and added a fifth objective: to test technologies for low cost transport links in different territorial contexts, plus integrated territorial corridor plans that help these links unlock wider economic and regeneration benefits; and better recognise these in business cases. This included two new partners (total now 16) and two extra demonstration regions (total now 7) in West Flanders Brugge-Zeebrugge (Belgium) and Saar-Moselle (a cross-border region France-Germany).

## Innovative technologies for light rail and tram – developing opportunities

Previous results from Sintropher show that low-cost systems, such as tram-train, tram-rail, and single-track tram systems, have clear potential but there is no single “best” solution and these opportunities must be assessed and adapted to city/regional circumstances. (Sintropher Report *Connecting European regions using Innovative Transport. Investing in light rail and tram systems: technological and organisational dimensions*. See references at end.)

Additionally over the 5 years of Sintropher, there have been dramatic developments in relevant transport technologies. The most important are (a) very long-life batteries that allow electric trams and trains to operate over substantial distances “off the wire”; (b) charging devices that boost battery life by recharging at stops en route – e.g. the supercapacitor technology demonstrated at the 2010 Shanghai Expo, or the induction system employed by Bombardier in their Remove trams and buses; (c) discontinuous

electrification that allows electric trains and trams to “coast” under bridges and through short tunnels where it would be impossible or prohibitively expensive to install overhead catenary.

Also, a recent Report by UK Network Rail “*Network RUS: Alternative Solutions*” (July 2013) - an input to its Route Utilisation Strategy for long-term planning of the national rail network - has reviewed these developments. This work followed a remit to think imaginatively about cost effective solutions for accommodating growth in UK passenger demand, and operating services more efficiently. The solutions which are considered in the UK context are generally over and above the conventional solutions such as types of rolling stock and 25kV AC overhead line electrification. It looked at tram-train, tram systems, battery-powered vehicles, hybrid light rail, personal rapid transit, bus rapid transit and guided bus, and electrification solutions for lightly-used routes. Its main focus is existing rail lines in the UK network, but it can also be used to consider options for new transport corridors in urban areas.

The Report’s overall comment is “Whilst some of the solutions are close to an appropriate stage of development (or adaption) for introduction onto the UK rail network, others will require more attention, for example on battery technology. It is important to be aware that, by definition, a process of innovation is a process of change and that some technologies that are not listed as appropriate at present may become appropriate after further development work. It is possible that over the next 30 years there may be some significant technological developments that could reshape the market for public transport and how it is powered.”

So within the project’s partner regions, there has been further feasibility work to test these kinds of innovative low-cost solutions in different city/regional contexts, including new developments in technical solutions.

The European reference resource informs project partners’ work, and is also intended to be of relevance to much wider audiences especially. Particular target audiences are governmental authorities and transport agencies at city, regional, national and EU levels; and transport professionals and practitioners who may be involved in the initiation and implementation of new transport links

The reference resource is a snapshot in time (September 2015) and obviously the field of technologies is developing on an ongoing basis - it is hoped to update the briefing papers periodically as necessary.

## Rubber-Tyred Trams

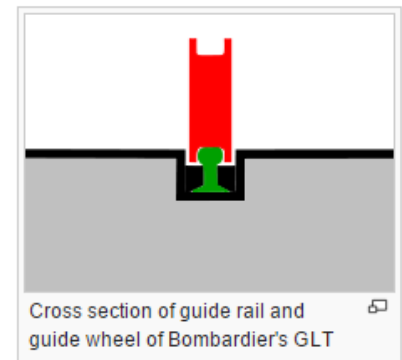
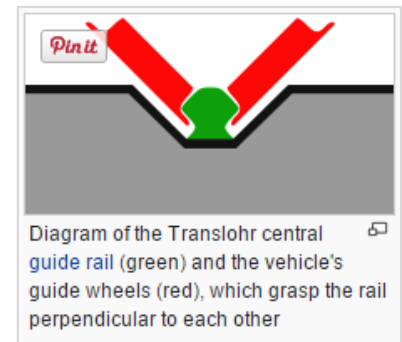
Rubber-tyred trams (also known as Guided Light Transit) are a unique system of light rail that uses a mix of road and rail technologies to deliver a conventional tramway. Originally called “trams on tyres” these systems have blurred traditional distinctions between trolleybus and tramway. Only two engineering companies globally offer rubber-tyred trams - Translohr and Bombardier – and share similar operating features. While the rubber tyres make these trams capable of running on road surfaces, a guidance rail running along the middle of trackway, 100% low floors, and pantograph and electrical engine operation have led transportation professionals to typify these vehicles as “rubber-tyred trams” despite some vehicles receiving bus-like operating classifications.



Left: Rubber-tyre tramway in Caen, France. Right: Guiderail for a conventional rubber tyred tramway.

## Technology

Two distinct systems exist: Translohr's and Bombardier's (GLT). Operate in similar ways with some differences. In both cases power is provided by overhead wires via pantograph and trams are steered by following a guide rail embedded in the road surface. Differences included the shape of the guide rail, the angle of contact between the guide rail and guide wheels, the vehicle's operability on non-guided sections, and the on-road classification on the vehicles.



## Attractiveness

- Provide significantly greater traction than steel wheels on rails, allowing rubber-tyred trams to climb gradients up to 13%.
- Rubber wheels also facilitate much smaller turning radii than conventional tramways.
- Infrastructure design can be simpler than with conventional tramways.

## Risks

- Rubber-tyred trams have recorded a high number of derailments.
- Tyres travelling over the same section of road repeatedly leads to surface warping and accelerated wear, increasing road maintenance costs along routes significantly.
- Rubber-tyred trams are much less energy-efficient than conventional tramways.
- Complications with road classification can significantly delay implementation.
- Rubber-tyred trams are considered a proprietary system in that once infrastructure has been developed operators and municipalities would face difficulties increasing or replacing vehicle fleets or infrastructure through different manufacturers.
- All systems installed to date have been more expensive than conventional tramways.



## Track Record

While there has been extensive use of rubber-tyred trains in metro systems since their first use in Montreal, Canada's metro system rubber-tyred trams have had a more difficult time breaking into the market. Currently there are only a handful of systems in operation worldwide namely Nancy, Caen, and Clermont-Ferrand in France, Tianjin and Shanghai in China, and L'Aquila and Mestre in Italy.

## Rubber-Tyred Case Study: Caen Tram



### System Specifications:

**Line:** 2 lines, 34 stations, 15.7km in length

**Rolling Stock:** GLT/TVR, 24.5m long, three-section articulated vehicles produced by Bombardier with a top speed of 70 km/h.

**Status:** Construction began in April of 2000, with the beginning of operation in November 2002.

**Cost:** € 227 million.

**Ridership:** 42,000 passengers / day in 2008.

## Why was the technology chosen in Caen?

*Improved traction on steep slopes:* the improved traction of rubber-tyred trams allowed for the routing of the tram through “critical areas” of the city centre and the city’s old quarters.

*Reduced infrastructure requirements:* the rubber-tyred trams are equipped with steering wheels and diesel auxiliary engines, allowing them to drive independent of the guided rail when travelling to and from depots.

## Benefits

- Able to travel up steep gradients.
- Reduced rail infrastructure needed initially.
- Rubber-tyred trams can operate in parallel lanes closer together than buses, as guided rails eliminate human error in steering.

## Drawbacks

- The technology has been considered extremely “niche” and suitable due to the incredibly short nature of the branch line.
- Demand may outpace capacity if ridership continues to increase, making the PPM60s obsolete.
- Caen trams are less efficient than buses.
- Vehicles behave erratically when not on guide rail, or when steering is applied while on guide rail.
- Snowfall causes significant problems for guide rail operation.

## Assessment

Reception of the rubber-tyred trams in Caen has been negative. Problems have plagued operation of the line, with a death reported during operation in 2004. Derailments, breakdowns, and the ballooning road maintenance cost of the lines have led to general dissatisfaction with the system.

## Future Prospects and Transnational Relevance

Rubber-tyred trams are looking to be in decline. While they initially promised cost savings and greater network flexibility a host of operational and technical problems have led Bombardier, one of only two developers of the technology, to stop offering the system. Without significant innovation, this technology is not likely to continue being offered as a viable alternative to traditional tramways.

## Transnational relevance

The technologies and approaches and city/region case examples on the reference resource are context-specific and reflect:

- the geographical context: for example the extent of the urban or regional rail (and/or tram) network and degered of electrification or non-electrification; density of traffic; extent of urban and rural areas; and physical urban conditions such as street width, environmental conditions, historic areas.
- the technical context: the national regime of technical standards for rail or tram infrastructure, rolling-stock vehicles, rail electrification power supply.
- the regulatory context: the national regime for matters especially safety standards, CO2 emissions, environmental impact.

Some of the technical and regulatory matters are EU-wide. A Sintropher Report on the technological and organisational aspects of innovative tram-based systems looks at the desirability of greater harmonisation across Member States where different standards exist (see references).

These potential low-cost solutions now need to be tested in different regional cases in EU Member States. There are some distinct physical differences:

- rail systems in most Member States were built at lower cost than in the UK, with fewer over-bridges and more at-grade road/rail crossings, which may reduce the benefits of some technological alternatives (e.g. discontinuous electrification).
- many areas have historic towns where conservation considerations make overhead catenary undesirable, increasing the advantage of battery-based solutions.
- in many European countries, in contrast to the UK, many urban tram systems have been maintained, or even constructed in the last 20 years, making tram-train solutions more relevant.

Even though the various approaches and case examples are context-specific, their transnational relevance is strong:

- the approaches offer a stimulus and possibilities for wider thinking by cities and regions in other European countries
- some or all of the various approaches might be potentially adaptable within the particular organisational and governance regime of another country, and technical and regulatory regime. For example the Governments' UK tram-train trial in Sheffield, Network Rail's UK trial with battery power for trains on a non-electrified heavy rail line in East Anglia, and (in Sintropher) Province Gelderland's feasibility studies for battery power to enable electric trains to operate on non-electrified routes in their regional network..

The reference resource should be seen from this perspective, as a means to promote knowledge transfer and learning across different NWE countries and regions.

## Sources

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## Further information

This paper was produced by UCL Bartlett School of Planning (Sintropher team members Charles King, Giacomo Vecia, Imogen Thompson) using desk research and expert comment. The paper reflects the views of the authors and should not be taken to be the formal view of UCL or Sintropher project

The European reference resource can be accessed on the following:

Sintropher project website

<http://www.sintropher.eu/publications>

POLIS website

<http://www.polisnetwork.eu/sintropher> or <http://www.polisnetwork.eu/res/resources>

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