

THE INTERNATIONAL LIGHT RAIL MAGAZINE

TRAMWAYS & URBAN TRANSIT



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PHOENIX: FIRING UP URBAN GROWTH



Tempe plans to expand integrated transport system



Small space ideas

Bern's ambitious multi-function plans



Onwards, Granada

Tramway success warrants new lines

- > German light rail extensions open
- > London projects gain investment
- > Services on Geneva extension begin



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Urban transit is hotting up in Phoenix



We often encounter transport planners who are passionate about their job, and it has been a real pleasure to make acquaintances with Mark Ziech, who has helped make a positive impact with the streetcar line that complements the already-successful light rail system in the hot climate of Phoenix, Arizona (see page 48).

We all know already that the dominance of the motor car in American cities for short distance journeys is on the wane and, as you can read, the vast student population of this major municipality of over 1.6 million is purposely catered for with a bespoke service that slashes journey times by jumping the traffic queues. It also only costs a dollar a ride.

Elsewhere, we have even more positive news to report, notably information that the African state of Angola will soon be on the light rail map. It has confirmed that it wants to proceed with a 39km (24-mile) line from Luanda to Kilamba, and now has a preferred contractor.

In South America, São Paulo in Brazil wants two city centre light rail lines to help alleviate its congested city streets, while in Europe there is something stirring in the picturesque Bavarian city of Regensburg. It has always felt left out since its tram routes were shut six decades ago (the former West German line received less public support than it would have in the Communist east). It seems confident that it could have the first of them open within six years. This could be rather optimistic though, as transport planners worldwide reckon on a least a decade to get through all the planning, procurement and construction phases.

The opening weeks of 2024 look good. Happy reading.

Matt Johnston, Editor

COVER: Streetcar plans could see Tempe (Phoenix, Arizona), expand its successful integrated transport system that also includes light rail and buses. Valley Metro

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German tramway extensions open

Hannover, Mannheim and Nuremberg welcome new light rail routes in December

The German city of Hannover has opened the latest extension of its *Stadtbahn* light rail system. Regional President Steffan Krach and Oberbürgermeister Belit Onay declared the new 3.3km (two-mile) surface line from Wallensteinstrasse to Hemmingen open on 9 December 2023. All services were free that day, with revenue-earning services starting on 10 December.

Work on the EUR91m (GBP78.8m) project started in 2019. An additional EUR1.3m (GBP1.1m) has been used to create a 170-space park-and-ride facility at Hemmingen.

On 10 December, two new tram routes became operational in Nürnberg (Nuremberg). Line 10 (Dutzendteich – Am Wegfeld) and Line 11 (Gibitzenhof – Tiergarten) run over existing tracks but supplement Lines 4, 5 and 6 in order to increase frequency. The



◀ The official first car on the opening day of Hannover's Hemmingen line was 3076, a HeiterBlick high-floor vehicle from 2018. 6083

delivery of 26 Siemens *Avenio* trams has boosted the fleet, allowing the peak run-out to be increased by ten trams.

Services on the 1.8km (1.1-mile) extension of Mannheim's tram system to Franklin began on 17 December. This EUR33m

(GBP28.5m) extension of the Baden-Württemberg tramway provides a new connection to a redevelopment of the former Benjamin Franklin Village US Army barracks.

Work started on the extension in January 2022. Its three stops

are served by Line 16, which terminates at the main line connection at Bensheimer Strasse.

However, it is expected that, by 2027, a through service to the city centre and Rheinau will be provided.

Final MAX double-tracking starts

Work to complete the final phase of double-tracking MAX's Red Line light rail service to the Oregon city's airport was due to start on 14 January. The first phase of the USD215m (EUR197m) project opened on 22 October. However, the new inbound alignment immediately north of Gateway, which includes new viaducts, is not scheduled to come into use until 26 February. All MAX services between 11th Avenue and Gateway will be suspended from 14 January to allow the work to be completed.

A tender for 11 new trams with off-wire capability is due to be offered in June 2024. These will be needed for the planned 1.4km (0.9-mile) extension from NW 23rd Ave to Montgomery Park, which will now not have overhead wires. Earlier plans to carry out a mid-life overhaul of the oldest trams have been dropped and those cars will instead be withdrawn when the first new off-wire-capable cars enter service in *circa* 2026. Construction of the extension is not expected to begin until the same year.

Angola moves close to securing its first LRT

The long-mooted Luanda Light Railway has taken a step closer to becoming reality, with the announcement by Siemens Mobility that it is working with the Angolan Ministry of Transport on the scheme.

The 39km (24-mile) double-track line would connect Luanda to Kilamba. This new city, backed by Chinese funds, has been under construction since 2008. Dubbed the Yellow Line, the LLR

would have 24 stops, with 68 four-car trains.

The project was first proposed in 2019. Siemens Mobility subsequently signed a Memorandum of Understanding in 2020. The LLR took another step forward in March 2023 when Angolan President João Lourenço announced that it would cost EUR1.3bn (GBP1.1bn) to build. Work to finalise the proposal is now on-going.

Auckland Light Rail put in limbo

New Zealand's new Transport Minister Simeon Brown announced on November 30 that he was "taking advice on these issues" after a stop-work notice was served on the controversial Auckland Light Rail project.

The scheme was authorised by a Labour government, which lost the November 2023 general election. Incoming National Party leader Christopher Luxon – now Prime Minister – has called

the project a "white elephant".

The scheme was to remove 14 500 cars from the capital's roads but the project involves extensive tunnelling under the city which had pushed the cost up to NZD14.6bn (EUR8bn). The Auckland Light Rail team is now in limbo after the notice to stop work was issued. City Mayor Wayne Brown has suggested that the line be built – but on the surface.

New timetable to serve Metrolink expansion

Increased demand has led Manchester Metrolink to implement a new timetable. The revised version features a new six-minute service between Etihad Campus and Manchester city centre. This has been made possible by extending Altrincham – Piccadilly services to Etihad Campus after 20.00 (Mon-Fri) and 18.30 (Sats) plus all day on Sundays. Double-ended trams will work the Altrincham – Etihad Campus service as well as between Bury and Piccadilly, while late-night tram services will continue to run until around 01.00 on Fridays and Saturdays.

Greater Manchester Mayor Andy Burnham said: "These changes, combined with the late-night trams, will provide a real boost to regular passengers while also presenting a compelling case for those who perhaps don't travel on trams as frequently to use Metrolink, which plays a central role in our integrated Bee Network transport system."

London wins capital investment package

TfL gains GBP250m funding for unnamed 2024 capital projects

The UK Government has agreed a GBP250m (EUR288m) funding package with Transport for London. The money will be used for capital investment projects for 2024 rather than covering day-to-day expenditure.

London's Transport Commissioner Andy Lord explained that TfL has worked hard to reduce its costs and to boost post-pandemic ridership levels in order to "be financially sustainable in terms of its day-to-day operations".

However, Lord said: "Additional Government support for capital investment in transport is needed if we are

to be able to continue to deliver vital improvements to London's transport network, unlock new homes and support growth across London and the UK."

It has not been announced what the funding package will cover but *TAUT* has previously reported that Phase 2 of the Piccadilly Line upgrade could only take place if the UK Government agreed to TfL's capital spending business plan (*TAUT* 1033). This second phase includes replacing the Piccadilly's signalling system, as well as procuring an additional 18 new trains to complement the 94 that are currently being built by Siemens. Other plans include

replacing 1972 *Stock* on the Bakerloo Line.

The funding deal requires TfL to announce how it will not only maintain and strengthen its financial position but also how it will "reform its pension scheme and [seek] efficiencies in its investment programme", a statement from the UK Government says. That plan is expected to be announced during the summer of 2024.

Rail Minister, Huw Merriman, said: "We have invested billions into the capital's transport system in recent years. This investment must be managed in a way that doesn't unfairly burden the pockets of taxpayers."

Eversholt funds new VLR cars

UK rolling stock leasing company Eversholt Rail is to fund the construction of three new battery-powered Revolution Very Light Rail vehicles from Transport Design International. The Revolution VLR (RVLR) concept is for an inexpensive vehicle that could return passenger services to mothballed or lightly-used UK branch lines.

One car is undergoing trials on the mothballed branch line to Ironbridge in Shropshire.

The three new pre-series vehicles will be battery-powered and complemented by a lineside fast-charging system. Construction is to start in 2024, with trials due in 2026.

The data from these trials will be used to support business cases for

long-term deployment of RVLR vehicles.

Eversholt Rail CEO Mary Kenny said the investment "demonstrates our commitment to delivering innovative, sustainable and attractive new rail products for the UK market. We are delighted to be continuing our partnership with Transport Design International."

Heavy snow brings chaos to Munich

The 44cm (17in) of snow that fell on Munich on 1 December 2023 brought travel chaos to the Bavarian capital. Only underground sections of the German city's *U-Bahn* could run on 2 December, along with a handful of long-distance trains; police were deployed at the Hauptbahnhof to maintain order.

S-Bahn services gradually returned on 3 December but freezing rain paralysed the tram network. This provoked an angry response from CSU parliamentary group leader Manuel Pretzel who called the situation a 'disgrace'.

The problem was exacerbated by the fact that two of the three works cars were undergoing attention, while snowplough-fitted trams no longer operate.



Works car 2942, built in 1926 and owned by a museum group, was used to rescue trams left stranded when falling trees brought down overhead catenary. A Unimog was

borrowed from Stuttgart while gangs of workers set to work with shovels, hammers and chisels to free frozen points. Normal service had resumed throughout by 10 December.

New trams for Olomouc

The Czech city of Olomouc has ordered nine air-conditioned *EVOI* bogie trams from Pragoimex in a deal worth CZK329m (EUR13.3m). Delivery of the 15.1m long vehicles is to take place within two years. The double-sided but single-ended trams will be used back-to-back on the Nové Sady line.

Shanghai shows off Type C

CRRC Changchun revealed the first *Type C* metro train on 1 December. Destined for use on the future Airport Express line, the trains have a maximum speed of 160km/h (100mph).

The 68.6km (43-mile) Airport Express will have nine stations and is expected to open in late 2024. It is to link Hongqiao and Pudong Airports with Shanghai East railway station.

Sarajevo construction work begins

Construction has started on a 6.5km (four-mile) expansion of Sarajevo's tram system. The new EUR26m (GBP22m) extension links Hrasnica to the current terminus of Ilidza.

The extension means that the current order for 15 new Stadler *Tango NF3* trams has been increased to 25. Testing of the first of the new trams began at Franowo depot in Poznań, Poland, in December. Trials will continue until February 2024.

Nottingham's trams financially secure

Tramlink, operator of the UK's Nottingham Express Transit (NET), has completed a financial restructuring project that it describes as "[securing] the future of the network for the next ten years".

The scheme has involved two years of negotiating loan terms with lenders. Tramlink has had to carry out this work as passenger levels are still 80% of pre-COVID levels while inflation has not only affected travel habits but has also pushed the cost of electricity upwards.

The restructuring has not been about managing cost. It also allows Tramlink to invest in new technology, recruit more revenue protection officers and update ticketing systems.

Tramlink CEO Tim Hesketh said: "There will be no changes to our customers in terms of how they use the trams as a result, and they can still expect the same great service from us. However, it gives us a secure financial position which will ensure we can keep on providing the people of Nottingham with reliable, convenient and sustainable travel for many years to come."

▼ The scene at the tram depot on 2 December. M. Schlaf

São Paulo plans city tram loops

New tram network announced for Brazilian city comprising two circular lines and metro links

Brazil's Minister of Cities, Jader Barbalho Filho, announced plans for a new tram network for São Paulo at the COP28 UN

Climate Summit in Dubai on December 1. The 12km (7.4-mile) network is planned to comprise a circular Blue Line and a figure-of-eight-shaped Red Line. Between

them, the two lines would serve 27 stops, as well as linking metro and suburban railway stations and up to five bus stations. Surface contact

current collection has been proposed to avoid the need for overhead wires.

Some BRL1.4bn (EUR260m) of the projected BRL2.1bn (EUR390m) cost would be met by the country's Growth Acceleration Program. The remainder would be provided by the city. If the public consultation and bidding process can be managed effectively, construction could start in 2024, with a planned completion date of 2027.

Clodoaldo Pelissioni, São Paulo's Minister for Urban Transport, said: "The idea of the tram here in the centre is to develop urban spaces and to connect them in bus, suburban rail and metro stations with a fast transport mode."

São Paulo's first generation tram system operated between 1900 and 1968. A metro system was introduced in 1974 and its six lines, now totalling 79.3km (49.3 miles), carry more than 1bn passengers a year.



▲ An artist's impression of the São Paulo tram. CPTM

Canberra extension work takes off

The first stage of an extension to Canberra's LRT system got underway on 8 December when the contract for construction was signed with Canberra Metro. The aim is to connect the existing network to Woden Town Centre.

Phase 2a is just 1.7km (1.1 miles) long but threads through the Australian capital to Commonwealth Park via London Circuit West. Construction work is due to start in late 2024.

Five new battery-powered trams will be built and the existing 14 CAF Urbos 3 cars will be retrofitted with batteries. A trial section of the proposed 'green' track is currently being assessed for its suitability to meet the Australian climate at the National Arboretum Canberra.

Midland Metro's new chair

Phil Hewitt has been appointed as the new chairman of Midland Metro, the operator of the UK's West Midlands Metro. Hewitt has previously served as Metro director at Transport for West Midlands (TfWM) and has chaired both UK Tram and the Light Rail Safety & Standards Board. He was to take up his new role in January.

Hewitt said, "I'm delighted to be taking on this role at such an exciting time for the region's tram system."

Kosice express line comes under threat

The future of Kosice's 13km (eight-mile) high-speed tramway is still uncertain after a council meeting in the Slovakian city in November decided that up to date patronage data was needed before it could reach a final decision. The high-speed line opened in 1964 to provide a dedicated service for the 25 000 people that worked at the large East Slovak Ironworks nearby.

Since the political upheavals of the early 1990s, the rise in car

ownership and the reduction of staffing levels at the steelworks, usage of the lines has declined. Lines R1-8 still operate but the track is in poor condition and frequency is reduced, in part due to the use of 19 articulated KT8s supplemented by 29 T6s.

Losses have continued to mount, and city deputies have called for the line to be closed or for it to be subsidised by the steelworks' owner, US Steel.



▲ A pair of Tatra T6 trams on shift-change service R6 to the steelworks. H. Tran

New Toronto tram in service

Toronto Transit Commission had a mixed end to 2023. The first of 60 new Alstom trams, 4604, carried Ontario Deputy Premier Sylvia Jones on 18 November prior to entering service the next day. It was joined by 4605 and 4606; the remaining 60 should be in service by the end of 2025.

However, an audit report into TTC's overhead maintenance department cited a lack of systematic maintenance and an insufficient workforce. The report cited the fire damage suffered by Flexity 4468 due to a fault in an overhead item that had no inspection regime.

TTC announced on 15 December that it would open the Eglinton Crosstown and Finch West light rail lines together in September 2024. This should coincide with the start of work on the 1.5km (0.6-mile) Eglinton Crosstown West extension.

Meanwhile, CLRVs 4024/170 have been shipped to a mining museum in the US while it is expected that some withdrawn Scarborough RT cars will be dispatched to Detroit.



▲ Double-ended Stadler Tango 1835 at the new stub track terminus ZIPLO, in front of the Harry Winston watch factory, one of several such factories that make up this industrial estate. A.Thompson

Geneva new Line 15 extension

Franco-Swiss cross-border line begins service; plans continue to extend line further

Revenue-earning services on the 2.7km (1.8-mile) extension to Geneva's Line 15 started on 10 December. The CHF125m (EUR134m) extension serves three new intermediate stops, one of which, Cherpines, will open only when the houses of the planned local residential development start to be occupied.

The tramline currently terminates at the Plan-les-Ouates industrial zone (ZIPLO). It is part of a cross-border line that is due to reach St-Julien-en-Genevois in France. Although

work on the French section is underway, construction of the 4.6km (1.8-mile) extension is currently suspended, while various disputes on the Swiss side are settled.

A northern extension of Line 15 to Grand-Saconnex awaits the opening of the new road tunnel des Nations, which is expected during 2024.

Meanwhile, utility relocation has started in the French conurbation of Annemasse as part of a second Franco-Swiss tramway. Line 17 will eventually connect Geneva to Lycée des Glières.

New monorail set for Dominican Republic

A consortium formed by Alstom and Latin American firm Sofratesa will provide rolling stock and operating systems for a new monorail in Santiago de los Caballeros.

The 13.2km (8.2-mile) elevated monorail is to link Cienfuegos and Villa Olympic. Under the EUR500m (GBP432m) contract, the consortium will

provide 13 four-car *Innovia* trains for delivery in 2025 and Alstom will install its Cityflo 650 GOA4 driverless signalling system as well as equipment for the depot.

The system in the Dominican Republic is due to open in 2025. It is to have 14 stations and is expected to carry up to 200 000 passengers per hour in both directions.



▲ Artist's impression of the completed monorail. Sofratesa

New Glasgow trains now in service

The first two new trains for the Glasgow Subway (UK) entered service on 11 December. It follows two years of testing of the Stadler trains on the 10.5km (6.5-mile) 1219mm-gauge line. The remaining 15 units will enter service during 2024, enabling withdrawal of the Metropolitan-Cammell and Hunslet trains (built in the late 1970s and early 1990s respectively).

The new vehicles form part of a GPB288m (EUR332m)

upgrade to the Subway, which has operated under Glasgow's streets since 1896, making it the world's third-oldest underground railway system. Other improvements include the installation of platform screen doors and new signalling.

The cars are 12.5m long but feature a more open interior than their predecessors. They are fully accessible, have air-conditioning, and can be converted to driver-free operation.

Regensburg considers tramway revival after 60 years

Regensburg council has backed a proposal by the Interessengemeinschaft Historische Strassenbahn Regensburg eV that could lead to the German city gaining its first tramway since 1964. The only surviving cars from the original

system, 47+79, have been restored to battery operation in the Polish city of Kraków. The proposal to operate them in Regensburg could be the precursor to creating a modern tramway on a north-south route linking the railway station and university.

Costing around EUR246m (GBP213m), it could be opened in 2030. However, public transport has only a 10% share of the Bavarian city's modal split and previous proposals for new tram systems have been unrealised.

Consultation is in progress.

Portuguese capital's 13km Violet Line given go-ahead

Lisboa's (Lisbon's) Violet Line has been given the go-ahead. The 13km (5.1-mile) route is to link Infantado and Hospital Beatriz Ângelo with the metro Yellow Line at Odivelas. Jardim do Radial, Ramada Escolas and

Jardim do Castelinho stations will be in subways. The budget is EUR527.3m (GBP455m).

The EUR405m (GBP350m) Red Line metro extension from São Sebastião to Alcântara has also been approved.

Tram line 15E re-commenced operation between Cais do Sodré and Praça da Figueira from 24 November, after being cut back since 2022 to allow the conversion of Rua da Prata into a tram/pedestrian/bicycle route.

Baltimore suffers electrical faults

Services on Baltimore's Light RailLink were suspended in December when an investigation revealed that its fleet of 53 cars were affected by high-voltage electrical problems. This followed a fire on the jumper cables of one train.

Some 30 buses were drafted in to provide a replacement service across the 48.3km (30-mile) network from 8 December. Services resumed on 23 December; these were then free until 2 January.

Alstom has a contract to refurbish the LRV fleet, which was constructed in two batches. The first was built in 1991-92, the second in 1997. Operator MTA has applied for a USD225m (EUR205m) federal grant to help finance a vehicle replacement programme.



PHOENIX: THE RISE OF THE STREETCAR

Tempe, a township within Phoenix, USA, has chosen the streetcar to expand its successful integrated transport system that also includes light rail and buses. *TAUT* caught up with Capital Planning Manager Marty Ziech and Valley Metro Communications Manager Susan Tierney to take a deeper look at the development of the streetcar, and how it fits within the urban landscape.

Phoenix has more than 500 000 inhabitants, all with differing transport needs, and as in many US cities, the dominance of the motor car is steadily diminishing. The opening of the three-mile (5km), 14-stop, Streetcar line into downtown Tempe on 20 May 2022 has slashed journey times for 40% of the population. It serves a student area where the average age of its ridership is 28.

So, how's it going?

Marty Ziech explains the background...

Marty Ziech (MZ): Until the middle of the last century, the Phoenix metropolitan area had an extensive streetcar network, mainly centred on the downtown area. Fixed rail urban transport fell from favour, not helped by a catastrophic depot fire in the 1940s that took most of the vehicles with it.

First, there just wasn't any political will to get the system restarted. Then the renaissance came, and we have been expanding our modern rail network, including light rail. In the course of building

one of our extensions (the South Central in downtown Phoenix), excavating the street has actually unearthed some of the old rails.

Our new streetcar system builds on the success of the light rail. It runs through three different municipalities at a decently high speed, and connects a lot of major activity centres.

Tempe, an inner ring suburb, is densely populated because it hosts Arizona State University, which has around 70 000 students on campus. We're known for urban sprawl, and there's no room for Tempe to expand into the desert because it's surrounded on all four sides by other townships.

We knew pretty early on that the way to continue growth and develop the university, and cater for all those who want to live and work here, is to sort out road traffic congestion. A lot of it is caused by local trips, especially by students trying to get from class to class. The campus is only a mile from end to end, but it can take ages.

A lot of the problems are associated with the very hot climate, and education typically

avoids summer. The city realised that the streetcar was a mode to complement the light rail.

Numerous different routes were identified and examined in detail, and what we now call the Valley Metro Streetcar connects a very dense area of student-style apartment housing along the Apache Boulevard corridor. It can bring in students from a couple of miles to the east of campus, as well as, of course, anyone from the community who is looking to make a similar trip.

It is routed around the outside of the complex, so there are quite a number of folks that board at the eastern end and then ride up to the north-western end of the campus, saving quite a bit of time. The alignment then goes north into downtown Tempe proper, where there are bars, restaurants, and entertainment. Moving further north, it turns along Rio Salado Parkway, an area of significant recent development with apartments, and businesses moving into shiny new glass towers.



▲ ABOVE: The new streetcar runs through three different municipalities connecting many of the major activity centres - including Arizona State University, downtown Tempe, and the Rio Salado Parkway where new businesses are moving into striking modern buildings. Valley Metro

It's working well. Tempe's streetcars are perfect for moving a lot of people very quickly. Light rail is also great, but it is quite expensive to run with two or three vehicles in a formation. We know this practice is common around the world, but not in the US.

We also have a fantastic bus service, and a number of our local routes connect to downtown Tempe from all directions. Some of the buses are named after different planets, so people call it the orbit system.

The challenge has always been their ability to cope, and we realised that the key corridor that the streetcar could assist with needed something more. The road is narrow, so siphoning out enough space to install a dedicated light rail guideway would not work.

The planning process began around 2010 and morphed along the way, because there were several ideas as to how to go about things.

How long does it take to get through the planning process from agreeing the concept, finding the funding and getting delivery of the first vehicle?

MZ: It has taken us 12 years. This is relatively typical in the US, depending on the size and the scope of the project – a smaller project can be faster. Typically, when we start the planning process, we don't say we want to build a streetcar, or where it should go.

We knew there's a lot of people who want to get to Arizona State University in downtown Tempe. We needed to discover where are they coming from, and how many are going to be using the service we want to provide. Gaining that kind of knowledge helps decide what the mode will be.

Then, of course, as with the vast majority of projects in the US, they have to compete for Federal funding. Other money also comes from the Capital Improvement Grant (CIG), which has different criteria. Overall, you get rated amongst all the projects submitted from across the US, because there isn't enough money for all of them. It's a competitive process, and they have to be matched by a lot of local money. If that's available, we can move pretty quickly.

Every country operates to different rules. In the UK, the moving of utilities is included in the financing for light rail [or the streetcar]. In the US, where does this sort of burden sit?

MZ: These costs are also associated with our project, and the final bill can be dependent on what things you include.

What's the structure of Valley Metro?

Susan Tierney (ST): I'll explain the easiest one first. Valley Metro Streetcar is operated by ACI (Alternative Concepts Inc) from Boston, Massachusetts, a private contractor that runs our light rail, streetcars and buses. They do our maintenance in house, but hire the operators.

The structure is complicated. Valley Metro is basically the umbrella brand for our regional public transport system. In the metro Phoenix area, we have two separate organisations under that Valley Metro brand, the Regional Public Transportation Authority (who we really work for), and also Valley Metro Rail (VMR). There are two separate boards of directors, and VMR is governed by four cities, Phoenix, Tempe, Mesa, and Chandler Regional Public Transportation Authority. We have 18 member cities, plus Maricopa County. Our county is about the size of Vermont. It's huge. Out of interest, Maricopa County is larger than Wales, UK.

There are also other funding sources, and while we are very viable, we can't provide the type of bus and light rail operations that we



▲ ABOVE: Tempe streetcars have unique air conditioning systems to cope with the high summer temperatures experienced in Arizona. Car 180 is at Sixth Street/Mill. Valley Metro

▼ A curious feature of the Tempe streetcar system is this roundabout that is shared with motor traffic. Careful signalling management is essential to avoid congestion and mishaps and congestion. Valley Metro



need. Regional funding helps, and light rail and the streetcar have to be paid for by the cities where they operate.

Have there been any archaeological or existing infrastructure barriers that you have had to work around?

MZ: Yes. For example, the bridge that vehicles run across when not in revenue service, just to get them out of the depot.

While the whole alignment is just along surface roads, we do run through a roundabout, which is unique to my knowledge. It took quite a lot of effort to devise how to best accommodate the streetcar through areas that require quite sharp turns.

How are the streetcars maintained and do they have special features?

MZ: Streetcar management is combined with light rail at the same facility. When we inaugurated the streetcar, we were in the middle of expanding it for an LRT extension, and able to easily modify one of the maintenance bays. The streetcars are of the same build quality, so they can run under the overhead wires and over the light rail alignment when they're not in revenue service.

When Brookville was tasked to build the streetcars, we had a couple of unique requirements. We don't use the same heating and ventilation system as the rest of the US because we need higher capacity to cope with our high temperatures. What's also unique is that because streetcars run through historic parts of downtown Tempe, the pantograph comes down and batteries take over.

Tell us about ticketing. Is it integrated?

MZ: There are a number of different ways to pay. You can use cash on buses and at ticket machines which sell all types, and we're rolling out actual fare cards and mobile phone access. The price is unified across the entire region; the one ride fare is USD2, and a day pass USD4. The streetcar itself is a little bit different, with maybe a USD1 ticket.

A dollar a ride, correct?

MZ: Yes.

Has there been modal shift?

MZ: I'm sure a fair number of folks are now



▲ ABOVE: Opening day for the Tempe Streetcar was on 20 May 2022, with six new Brookville Liberty NXT 70% low-floor trams providing a 15-20 minute service from 06.00-24.00. Valley Metro

choosing the streetcar. At the eastern end on our main alignment at Dorsey and Apache, there is significant interchange.

How has COVID affected you long-term?

MZ: We didn't see as big a drop as other major US cities such as New York and San Francisco. The reason is that we run past essential employers and medical facilities. The streetcar only opened in May of 2022, so we only know that it has doubled our expectations with over 800 000 customers so far.

What barriers did you have to overcome strategically, that might have stood in the way for the future?

MZ: Like everywhere else in the world, it just seems that the costs are very high, and US projects tend to be very expensive. We look at public funding, mainly federal, and we have to invest to get a return. Certainly with the funding constraints that we have, it's making sure that we're not only expanding our system, but doing a great job of running what exists and keeping it in good repair.

What about extensions?

MZ: The streetcar has an extension in the planning phase right now, which is to run east from its current north east terminus, through an area that has a significant amount of investment in residential and commercial activity and will expand the higher density

core of downtown Tempe to the east.

From there, it goes into the city of Mesa to serve a stadium where half the US' National League of Baseball teams do a month's spring training before the season starts.

Then, we can turn south and east along Rio Salado Parkway from its end of line in Tempe all the way into Mesa, serve another shopping centre, turn south, and meet up with the existing light rail alignment again to provide a transfer point. This streetcar extension happens to be at the heart of Mesa's Asian district, our kind of Chinatown.

Will all this be publicly funded?

MZ: It's too early to say. We're looking at a mix of local and federal public money. If Federal funds are difficult to win in a given year, we have to work out how can we make up the difference, such as from property developers, financiers, and parking levies.

The total capital cost for the current streetcar was around USD200m, with USD112m from regional sales tax fund, and USD13m came from a public private partnership that included the City of Tempe, Arizona State University, and over a dozen major employers and property owners.

When you're building a new system, which aspects do you think in the US are proportionally expensive?

MZ: That's not really something that we look into. Showing the economic development benefit is something that we're very proud



MARTY ZIECH

Marty trained in geographic systems development before a switch to urban planning. He has a keen interest in public transport, which he says offers opportunity for someone who doesn't want to own or can't afford a car.

He adds: "I see transit as a great unifier. I went to urban planning school and gained a master's degree; I was offered a position at Valley Metro and moved to Phoenix seven years ago.

"It's a lot of fun, especially when you get to see things get built. Projects have long timelines, and some things I'm working on will not happen for a long time."

◀ LEFT: Valley Metro says that people are now opting to use the streetcar instead of driving, with a significant number of students thanks to links with the university campus. Valley Metro

of, and our cities do a great job working with developers to ensure that things work well. Our light rail alignment in particular has seen a ton of economic growth along its corridor.

Overall, you have to get people excited about something that really is going to be transformative. At the beginning of the light rail process, the folks who worked on getting the light rail project moving had to take giant leaps of faith.

They had to do a great job of communicating what the benefits would be to the public, so they would vote for it. We're possibly unique in the US that a lot of what we do is via the ballot box, although we do of course have our elected officials to guide the process.

So once you've got the east side built, where do you extend to next?

MZ: The next expansion from the eastern extension into Mesa is actually going further into the city of Mesa to connect with retail locations, and a major regional hospital that would be right along the alignment. It also has the largest community college in the state.

Will better public transport grow the population?

MZ: The population of Mesa is around 500 000, making it the third largest city in the state of Arizona. Only Tucson and Phoenix are larger. Mesa is doing a number of different things. It's reinvesting in its



◀ **LEFT:** Another unusual feature of the Tempe light rail system is that cars are allowed to use the formation - as here at Third Street/Mill. Valley Metro

downtown, where light rail runs through. We are conducting a Transit Oriented Development (TOD) study right now with a federal grant for some of the streetcar expansion. It's a combination of reinvesting in the downtown and the older west side, and then expanding further.

Finally, the streetcar launch in May 2022 must have been a proud moment for you all.

MZ: Yes, we were all really excited, but even more when the autumn university term began.

Summer is our hottest time of year, and our lowest for tourism. It was really a good time for local residents to have streetcar experience first, and when the students arrived, it was crush capacity - I mean no space. I don't want to say it was at New York City level, but there are online photos where you see people just continuing to pile on. **TAUT**

12 YEARS FROM JUST AN IDEA TO OPENING

Phoenix's streetcar concept was agreed in 2010, and it took five years to win USD75m of Federal funding. More money was later forthcoming from the American Rescue Plan, Maricopa County sales tax and the City of Tempe, and construction began in 2017.

It is operated by six double-ended *Liberty NXT* hybrid battery 70% low-floor vehicles built by Brookville Equipment Corporation of Pennsylvania. They take power from the overhead whilst recharging. The cars are based on similar vehicles running in Dallas, Milwaukee and Oklahoma City, and can carry up to 32 seated passengers with over 100 standing.

There are two interchanges with Valley Metro's light rail system, at 3rd Street and at the eastern Dorsey Lane terminus. Both systems use standard-gauge track and 750V dc overhead - and all the vehicles can run over a connection near Dorsey Lane to access the existing Valley Metro Rail depot and maintenance centre at 48th Street.

The streetcar system has 14 stops. The central northbound route along Mill Avenue has no overhead, and nor does part of the alignment on Rio Salado where there is also a short single-track section.

Source: *TAUT (Vic Simons) February 2022*

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PRIVATE RESEARCH ONGOING FOR STOURBRIDGE VLR

VLR Operator Pre Metro is working with Oakham Research to conduct further public consultation about the proposed light rail service between Brierley Hill and Stourbridge, the Dasher.

The Stourbridge Dasher is a proposed passenger service which builds upon the success of the Stourbridge 'Shuttle' and aims to increase patronage within this sector of the West Midlands.

Previous surveys on the proposal took place between November 2019 and May 2020, where 87% of the 1438 responses stated that residents within Stourbridge and Brierley Hill were in favour of a proposed light rail link between the two locations.

Since the previous research was conducted, the West Midland Metro extension between Wednesbury and Brierley Hill has begun construction. The proposed service would connect with this development, utilising the existing freight dual track between Stourbridge Junction and Canal Street.

The aim of this latest round of questionnaires and field research is to engage with local businesses online and on the ground regarding their viewpoints on the Dasher.

The Dasher could support proposed Dudley Investment Zones, described by the West Midlands Combined Authority as a "transformative package of brownfield sites around the route of the Metro extension from Wednesbury to Brierley Hill", and represents longer-term ambitions for a commercial and property development strategy within the Black Country.

They are hoping to gain a greater understanding of the impact that this proposed service could have on local businesses' ability to recruit and retain suitable staff alongside the knock-on effect in terms of sales and prosperity with easier accessibility and passenger footfall.

As well as this, Pre Metro hopes to understand the potential ticketing packages

that could be offered to local businesses to encourage regular commuter patronage. With hundreds of local businesses within 1km (0.6 miles) of the proposed stops, understanding which incentives can benefit Black Country businesses is important to the local operator.

Steve Jasper, Operations Director of Pre Metro, stated: "We are confident that the passenger service from Stourbridge to Brierley Hill will benefit everyone along the route and beyond – businesses, commuters, shoppers and leisure travellers. The survey will provide further data to support our proposals.

John Poole, Research Director at Oakham, added to this, highlighting that: "This is a great opportunity for local businesses, large and small, to shape improvements to the local transport network and tell us about their thoughts on this initiative."

With over 200 responses to date, the findings of this research will conclude and be made publicly available in early 2024.



As the premier VLR operating force, we are working with leading light rail partners as well as the Local Authority to further understand how the development of the 'Stourbridge Dasher' can be facilitated; enabling greater economic opportunities and accessibility for the Black Country.



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BERN:

GROWING FOR THE FUTURE

After previous network growth over a decade ago, the Swiss capital city Bern is once again taking the chance to upgrade and extend its light rail system to make it fit for the future. Andrew Thompson delves into the plans.

With a population of around 135 000, Bern is one of the smaller capital cities in Europe. At the same time, this UNESCO World Heritage site has always been at the forefront of public transport innovation and features infrastructure assets that many larger cities lack. Aside from the ever-growing tram network (currently 31.5km/19.6 miles), there are two funiculars, a 13km (eight-mile) trolleybus system with three lines, and a metre-gauge *S-Bahn* network run by Regionalverkehr Bern-Solothurn (RBS). That's in addition to the main line commuter trains operated by SBB and BLS.

During the coming years the metre-gauge tram network will continue to grow, as a 1.4km (0.9-mile) extension of line 9 from Wabern – Kleinwabern will be built between 2025-28, with two new intermediate stops at Bächtelenpark and Lindenweg. The new tram terminus at the Kleinwabern *S-Bahn* station will aid easy connectivity and encourage additional modal shift in this southwestern part of the city. The Kleinwarbern project is currently budgeted at CHF66.4m (EUR70.2m), with federal and cantonal funding covering CHF56.5m (EUR59.8m).

An even more far-reaching and complex project is the conversion of the busy bus line 10 to Ostermundigen into a new tramway branch. With over eight million annual

users, this bus line is overcrowded and no longer fit for purpose. Additionally, the town of Ostermundigen is expected to remain a hotspot for future population growth and residential development. During peak hours, the existing headway of articulated buses on line 10 is already every two or three minutes and a further increase in frequency is no longer possible. An excessive number of buses on this route already contributes to road congestion.

From the junction with tram line 9 at Viktoriaplatz to the planned Oberfeld terminus in Ostermundigen, the new tram branch will run 4.5km (2.8 miles) and serve ten intermediate stops, including Ostermundigen *S-Bahn* station for main line connections. At the earliest, construction could commence in late 2024/early 2025, with works expected to last for 4-5 years. The project also includes the overhaul of public utilities and modernisation of roads and cycle paths.

These two future additions to the network will be the first since December 2012, when the 1.1km (0.7-mile) extension of line 9 from the fairgrounds at Guisanplatz to the *S-Bahn* station at Wankdorf Bahnhof opened. This followed 6.8km (4.2 miles) of new tracks in the west of the city with the two spurs to Bümpliz and Brünnen Westside, which opened in December 2010 and replaced previous trolleybus lines that had reached

▲ Originally built as double-ended, three-section high-floor LRVs by the consortium of Schindler, SIG and BBC in 1987-88, the nine *Tram 2000* units were retrofitted by Stadler in 2010 and lengthened with a low-floor module in anticipation of their extended city-centre running on line 6. Here, car 83 passes the landmark Kirchenfeld Bridge that spans the south side of the River Aare, on 29 May 2021. To the rear is the 100m Gothic spire of Bern's iconic Münster and the massive red roof of the municipal Casino, a concert and event hall. All images by Andrew Thompson unless stated otherwise

capacity. Prior to these two extension projects in the new millennium, the Bern tram network had seen no changes since 1973, when a 1.7km (one-mile) extension was added from the Egghölzli junction to Saali in the east of the city.

New trams for new lines

In order to operate the future extensions and enlarged network, Bernmobil ordered 27 *Tramlink* LRVs from Stadler in late 2019. The initial series is for 20 double-ended vehicles and seven single-ended trams. Using contract options, another 23 *Tramlink* could be procured. Built at Stadler's Valencia works, the first *Tramlink* 911 was delivered to Bernmobil's modern depot at Bolligenstrasse in February 2023. After more than half a year of staff training, trial running and final certification, the first *Tramlink* vehicles were ready for revenue service by November 2023 and subsequently deployed on line 7 between Bümpliz and Ostring, later also on line 8 from Brünnen Westside to Saali. All 27 *Tramlinks* are expected to be in squadron service by 2025.

As part of the fleet renewal, Bernmobil will withdraw the oldest LRVs that it currently operates. These date from the 1980s and are the nine double-ended *Be 4/10 Tram 2000* units that are exclusively used on the interurban line 6 to Worb Dorf and actually owned by RBS, as well as the 12 single-ended ▶



Class Be 4/8 Vevey trams, last deployed on lines 3 and 7 only. When originally launched in 1989, the Vevey trams were the first accessible trams in Bern, with a low-floor ratio of 70%. The Tram 2000 sets were initially produced as three section type Be 4/8 high-floor vehicles, but were retrofitted with a short low-floor module in 2009-10, making Bernmobil's entire tram fleet barrier-free at that point. Initially it was feared that both the Tram 2000 and Vevey units would have to be scrapped, for lack of a cascade option, although most recently the Ukrainian city of Lviv has emerged as a serious option for the Vevey trams, pending technical compatibility of the stock on Lviv's metre-gauge tram system (see interview).

In addition to the tramway and the historic trolleybus network dating from 1940, Bernmobil is also in the process of electrifying its remaining bus lines through the acquisition of electric vehicles. The most recent conversions are lines 17 and 21, with lines 19 and 28 expected to follow. All of Bernmobil's vehicles and services are to be electric at the very latest by 2040.

With the exception of the north-south line 9, all other tram lines in Bern have a clear-cut east-west orientation. Due to the limited capacity of the lone trunk line on the over-used bottleneck through the city centre between Bahnhof and Zytglogge, line 3 is cut short at Bahnhof and therefore only has a length of 2km (1.2 miles), serving just seven stops. Bernmobil has recognised the operational vulnerability of its tram network with the overused, non-resilient central trunk line and lack of a diversionary corridor. Correspondingly, a major case study

was presented in 2023 highlighting three potential routes for a second tram trunk through the city centre.

Yet, given the small size and narrow scale of Bern's medieval centre, which is located on a peninsula within the River Aare and therefore marked by tight alleys and limited available space for new infrastructure, all three options have major drawbacks and are likely to prove unpopular, expensive to implement, as well as politically controversial. It's entirely possible that all three options will be deemed as non-starters by municipal authorities, who will potentially prefer the established, decades-long status quo, rather than unpopular or impractical changes.

One bit of new infrastructure that Bern cannot do without in the next decade is a new tram depot, as in 2020 the old Burgernziel facility was demolished. Although the modern Bolligenstrasse depot from 2011 has been extended by seven tracks in 2023, taking advantage of its modular design to accommodate the new fleet of Tramlinks, this facility offers no further space for future extension. Additionally, the historic depot at Eigerplatz, with its main workshop and inclusive trolleybus stabling facility, is also at capacity and allows no space for growth either.

After significant research and site scouting, Bernmobil has proposed an innovative solution based on a site at Bodenweid in Bümpliz (see interview). Because Bolligenstrasse is on the east end of the tram system, any additional facility needs to be at the western periphery of the network, in case of disruptions in the city centre and along the bottleneck from Bahnhof to Zytglogge. While final political approval for the Bodenweid project is still outstanding and finance by municipal and cantonal authorities yet to be finalised, Bern lacks any realistic alternatives for other depot sites and during the past two decades there has always been significant regional resistance to building new transport infrastructure on greenfield sites.

Thanks to its ongoing fleet modernisation and enlarged network by the end of the decade, Bern is well positioned to cope with growing public transport demand and maintain the city's green image.



◀ LEFT: Pending final verification of their technical compatibility with the metre-gauge tram network in Lviv, the three-section Vevey cars could help enhance public transport and increase the low-floor ratio of the local fleet in the attractive western Ukrainian city that is also a UNESCO World Heritage site. Of the 12 Vevey trams, 11 would be passed on to Lviv and one would remain in Bern as a heritage vehicle. In order to fill the role of heritage tram, the remaining Vevey will need to be repainted into its original olive green and cream livery from 1989. Dark red livery with black highlighting was not introduced in Bern until 2000 and involved a major rebranding exercise.



◀ LEFT: Running eastbound to Ostring on line 7, the seven-section, double-ended Tramlink 912 calls at Zytglogge on 19 November 2023. To the left is the green copper dome of the Swiss Parliament, which opened in 1902.



HISTORIC CHALLENGES

Although photogenic, its Achilles heel is the bottleneck corridor through the historic old town between Bahnhof and the iconic Clock Tower Zytglogge, which is pictured to the rear (below). This 550m section between Bahnhof and Zytglogge is used by the four tram lines 6, 7, 8 and 9, as well as trolleybus line 12. Because Bern is the federal capital of Switzerland it is often the site of political rallies, when this corridor is quickly disrupted. Tram traffic on the western section of the network is then terminated at Bern Bahnhof, while services on the eastern section run via Zytglogge and Viktoriaplatz to the northern terminus of line 9 at Guisanplatz or Wankdorf Bahnhof.

If Zytglogge is blocked, there is no back-up option for maintaining services on the eastern section of the network. To counter this lack of operational resilience, a reversal point at Helvetiaplatz is to be installed.

Bernmobil ordered 20 double-ended Stadler *Tramlinks* to replace nine double-ended *Tram 2000* units. The disadvantage of this is that the double-ended, low-floor *Tramlinks* offer fewer (and less comfortable) seats than the *Tram 2000* sets. For short distances such shortfalls can be tolerated, yet on the long interurban line to Worb, the *Tramlinks* represent a step back in passenger comfort.

Three weeks after being launched into revenue service, the new Stadler *Tramlink* 912 is seen running through the historic city centre on 19 November 2023 with a line 7 service westbound to Bümpliz.



▲ ABOVE: Car 741 is one of the 12 type *Be 4/8 Vevey* trams, which were the first flow-floor LRVs in Bern when launched in 1989-90. During their final years in service, these comfortable and reliable units were confined to lines 3 and 7. On 30 September 2021, 741 is departing Zytglogge with an outbound line 7 service to Ostring.



▲ ABOVE: *Combino* 671 is one of the newer series of 21 *Be 6/8* seven-section trams that Bernmobil acquired from Siemens in 2009-10. Car 671 carries a yellow and black colour scheme that pays homage to the popular local football team and current Swiss champions BSC Young Boys. The vehicle livery denotes the years in which Young Boys either won the Swiss Cup or Swiss football championship. Here, the single-ended *Combino* has just departed from the central interchange at Bern Bahnhof and runs past the old infirmary (Burgerspital) from 1742 with an outbound line 9 service to Wabern.



▲ ABOVE: *Combino* 761 is one of 15 low-floor, five-section *Class Be 4/6* LRVs, which Siemens delivered in 2002-4. In 2009, eight were lengthened to become seven-section type *Be 6/8*. In September 2020, the extended *Combino* 761 passes along Viktoriaplatz with an inbound line 9 service. To the right is the namesake Viktoriastrasse.

PLANS FOR BERN: THE WAY FORWARD

Rolf Meyer, Head of Communications at Bernmobil, talks to Andrew Thompson about design and planning, construction challenges, new vehicles... and football.

➤ Rolf Meyer, Head of Communications at Bernmobil. Bernmobil



TAUT What are the next steps with implementing the approved network extensions to Kleinwabern and Ostermundigen? What is the current timeline for these major projects?

ROLF MEYER Currently the Federal Office of Transport is processing the relevant paperwork and conducting the approvals procedures for both extensions. We hope to receive building permits for both projects sometime during 2024. Construction on both extensions is scheduled to begin during the second half of 2025. Tram line 9 to Kleinwabern is scheduled to go into operation in 2028, while the new tram route from Bern to Ostermundigen is slated for inauguration by late 2029.

TAUT What are some of the current challenges with planning and financing the proposed tram depot at Bodenweid?

ROLF MEYER The challenges are diverse. The main issue is the limited space in a small city like Bern. That's why new building projects place an emphasis on spatial densification. This makes the planning process quite challenging though, because a new building is required to fulfil different functions. At the Bodenweid site, it is planned to set up football fields on the roof of the future tram depot, as public football grounds currently occupy the site and these sports fields

are owned by the City of Bern. Designing such a multi-purpose building from scratch and making it suitable for an array of different functions, makes the planning process quite complex and also increases construction costs, compared to a conventional project that uses only standardised methods.

“New building projects place an emphasis on spatial densification. This makes the planning process quite challenging, because a new building is required to fulfil different functions.”

Indeed, a challenge in itself is the conceptual design and spatial dimensioning of a building that is intended to be in reliable use for at least 50 years. Planning everything so that the size and scale of the building passes the test of time, yet also proves flexible enough for future adaptations or forthcoming technologies, is very demanding.

TAUT In March 2023, numerous Swiss media outlets reported that Bernmobil's Vevey and Tram 2000 vehicles would have to be scrapped after their staged withdrawal in Bern and subsequent replacement by Stadler

Tramlink units in 2024-25. As of late 2023 though, it seems there is a good chance that these partially low-floor trams might get cascaded to Lviv in western Ukraine. What has happened since spring 2023 to create this positive development?

ROLF MEYER Our initial search for a potential buyer for the Vevey trams was unsuccessful. Due to the Swiss media reports that the trams might

get scrapped, the Ukrainian embassy in Bern became aware of the matter and interested in our trams. After the Ukrainian embassy contacted us, formal talks between Lviv city authorities, Bernmobil and the Swiss State Secretariat for Economic Affairs (SECO) were held. In case the transfer will be feasible, the Swiss government will cover all transport costs for the tram cascade to Lviv, through its specialised agency SECO.

So far these Swiss-Ukrainian discussions, which have also included a specialised company, have been positive. The final decision should be known by early 2024.

TAUT What is the current trend in public transport utilisation in Bern? How do ridership numbers in 2023 compare to pre-pandemic levels in 2019?

ROLF MEYER The number of passengers on lines inside the city is currently around 5% below the 2019 level. In contrast, passenger numbers on the regional lines outside the city are already back at the 2019 levels or even slightly higher. In the city, we have noticed that the service peak in the morning is less intense than before the pandemic. Here we particularly notice that home office and part-time work have impacted commuter behaviour after COVID. Bern has a lot of office jobs (federal administration, SBB, post office, etc), which is why this effect is particularly noticeable compared to other Swiss cities. **TAUT**



▲ ABOVE: A visualisation of the new depot site at Bodenweid. As the depot will be built on an existing public football ground, the proposal is to design new football pitches atop the roof of the tram depot. Image courtesy of maaars architektur visualisierung zürich

BEATING FATIGUE: NEW AWARENESS TECHNOLOGY

When a tram derailed at Sandilands in 2016 and it appeared that driver inattention was the cause, it prompted TOL to evaluate the role of fatigue in accidents. Richard Foster looks at two driver awareness systems that have the potential to be game-changers for fatigue management.

Within the space of a mere hundred years, human beings have abandoned their biologically mandated need for adequate sleep – one that evolution spent 3 400 000 years perfecting in service of life-support functions. As a result, the decimation of sleep throughout industrialised nations is having a catastrophic impact on our health.”

Neuroscientist Matthew Walker’s statement is a powerful one for a light rail magazine but bear with us.

The circadian rhythm is the body’s internal clock. It tells you when to go to sleep and it tells you when to wake up. It is coded to work with the rising and setting of the sun.

The development of artificial light has destroyed the natural rhythm. We can now control day and night. Switching on a light to extend the day may now mean we can get more work done but, as Walker explains in his seminal book *Why We Sleep*, this comes at a price. Humanity is not sleeping properly and the problem is compounded by the pressures and stresses of everyday life.

Shift work exacerbates the problem further... and now we get to the crux of the matter.

Driving a tram requires intense concentration but it’s a job built around shift work. There are early morning starts or late night finishes, and drivers can find themselves swapping between the two in

fairly quick succession. That plays havoc with the circadian rhythm, leading to fatigue. Yet there’s a stigma attached to admitting that.

Tiredness could equal laziness; tiredness raises questions about your lifestyle outside work. No one wants to admit to being tired.

Walker says that concentration is one brain function “that buckles under even the smallest dose” of sleep deprivation. Studies have found that ten days of getting six hours of sleep a night resulted in the same performance impairments as going without sleep for 24 hours.

Of the recommendations that the Rail Accident Investigation Branch made in the wake of the Sandilands accident of 9 November 2016, two are relevant here: ▶



▲ ABOVE: A pedestrian makes his way via foot crossings between platforms at Croydon, UK, as a CR400 approaches. The Croydon Sandilands accident in 2016 prompted TOL to research driver awareness systems, such as its since-implemented Guardian system since implemented, and minimise risk due to driver fatigue. Neil Pulling

Driver awareness

- Research and evaluate systems capable of reliably detecting driver attention state
- Minimise risk due to tram driver fatigue associated with both work and out-of-work activities

While those recommendations were specifically aimed at London Trams, fatigue – and the associated loss of concentration and impairment – is an issue faced by tram and light rail operators the world over.

What is 'enough' sleep?

'Chronically sleep restricted' is defined as routinely getting fewer than seven hours sleep a night. One of the common symptoms of the 'chronically sleep restricted' is the 'micro sleep', a momentary lapse in concentration where the eyelids partially or fully close and the brain, Walker says, "becomes blind to... all channels of perception".

A micro sleep while driving – be that a car or tram – can be disastrous. For example, if a driver has a two second micro sleep while travelling at 70kph (43mph), the vehicle will cover 38m with the driver asleep.

That's why UKTram views FOCUS+ as a "breakthrough".

FOCUS+ might look like a wristwatch but it's actually a small biometric device that can warn of fatigue, pre-empting a loss of concentration event, such as a micro sleep.

FOCUS+ owes its origins to Edinburgh Trams' Driver Innovation Safety Challenge (DISC). Backed by Transport Edinburgh and UKTrams, this challenge offered GBP168 000 (EUR196 000) to develop a device or system that would "as close to real time as possible" warn of the early symptoms of some form of loss of concentration or focus.

▼ **BELOW:** TOL has discovered that fatigue events are more common in rural locations, resembling this stretch in Stuttgart. Neil Pulling



▲ **ABOVE:** FOCUS+ is hailed as a 'breakthrough' by UKTram – this small biometric device is worn on the wrist and monitors signs of fatigue and loss of concentration. UKTram

The device's five sensors measure the user's heart rate, the heart's electrical output, blood oxygen saturation, temperature (both of the skin and of the environment) and the skin's electrical response to sweat glands (called the galvanic response). Wearing the device over time allows the FOCUS+ to develop a baseline reading. It will then recognise a change to the baseline that could result in a fatigue or concentration loss event and thus warn both the wearer and the control room.

Developed by Integrated Human Factors of Edinburgh, the first trials took place on the Edinburgh Trams system in 2020. After a year or two of further development, FOCUS+ was trialled across Blackpool, Manchester Metrolink and Sheffield Supertram systems in 2022.

Both UKTram and the Light Rail Safety & Standards Board participated in FOCUS+'s development and LRSSB Chief Executive Carl Williams said: "To establish the 98% accuracy of the algorithms used to assess the data is certainly a remarkable achievement.

"It clearly illustrates the potential of the device and the underlying software to effectively detect driver fatigue in real-world situations and to further enhance light rail safety."

James Hammett, Managing Director of UKTram, said: "The independent testing report confirms the potential of FOCUS+. In the future, it could play a key role in fatigue management system guidance, ensuring the well-being and safety of network employees and their passengers."

IHF's CEO Neil Clark added, "FOCUS+ was three years in the making. It represents a significant leap forward in proactive fatigue monitoring and workplace safety. I am excited that we have had the system endorsed by the LRSSB and can now go on and fully commercialise the system. We have already had enquiries from as far away as Australia, with its versatility making it a consideration for many hazardous sectors."





◀ LEFT: The first trials of FOCUS+ took place on the Edinburgh Trams system in 2020, before it was trialled in Blackpool, Manchester and Sheffield in 2022. A 98% algorithm accuracy rate means that the software can reliably detect driver fatigue in real-world situations, such as this pictured on the Edinburgh system in heavy traffic. Neil Pulling

All in the eyes

Using biometric sensors is one way to monitor a person; London Trams has taken a different approach, based on a Percentage of Eye Closure (PERCLOS) and Distraction Monitoring system, delivered using camera-type technology. This system is called the Guardian device.

Guardian monitors the driver's face – in particular, the eyes – and if it thinks attention has wandered for more than two seconds, an alarm will sound in the cab and the driver's seat will vibrate.

Ben Groome is Service Delivery Director at Tram Operations Limited (TOL), which operates the London Trams system on behalf of Transport for London. He described the Guardian system in more depth at the 2023 UK Light Rail Conference (TAUT 1029).

He said, "The drivers are the first people to be aware that they've had a [fatigue] event. They get the sound, they get the vibration and then whether it was a distraction or whether it was a microsleep type event, more often than not, the driver's attention will turn back onto the track and what is in front of them."

When the Guardian system is activated, it sends a message to a data processing centre, which categorises the event; the centre then contacts the TOL control centre and they check if the driver is okay.

Both FOCUS+ and Guardian tick the RAIB's first recommendation of a system that detects driver inattention. They are different from driver aids that prevent collisions or overspeed events.

TOL has made fatigue management a core part of its ongoing operation and is using the five years' data received from Guardian to support decision making and staff wellbeing.

Groome said: "Invariably, we now find that before control receive the information from the data centre, the drivers are already contacting the control room to say that they've had an event."

This is a remarkable turnaround from 2018 when the Guardian was introduced. Drivers

started blaming Guardian for blurry vision and skin blisters and in some cases they reported for duty wearing diving masks as eye protectors. To address this issue TOL took action, by contacting Public Health England to undertake exhaustive research on Guardian. The report concluded that there was more infrared light coming from your [television] remote control than from Guardian.

"The report has done wonders for people in trusting Guardian," Groome said. "I think [since 2018], we've had one report that [Guardian] was affecting their eyes."

Guardian was complemented by a comprehensive training programme that highlighted the risks of fatigue and ways to combat it. Everyone at TOL, from executives to the rostering clerks, have received bespoke fatigue training for their roles. A fun day at its Croydon depot helped make drivers' families aware of how lifestyle can affect fatigue levels.

"I think it was great that the kids saw what the impacts [of fatigue] on their parents were," he said, and joint responsibility can be seen from the individual managing their lifestyle and TOL providing support in the working environment.

Both FOCUS+ and Guardian warn of an impending fatigue event. But how do you prevent that driver from being fatigued in the first place?

Training and fun days can only do so much. This is why Guardian sends a message to a data gathering centre because TOL uses the data to manage fatigue, thus meeting the second RAIB recommendation.

Even an increase in reported cases of fatigue is useful.

"It's one graph we don't mind going up," Groome said. "Where they've done their initial refresher training, we see an initial spike in reports and the drivers feel able to report when they're feeling fatigued, which is something that we want them to."

TOL now has five years' worth of data, which is revealing interesting patterns. For

example, more fatigue events are reported in the last five periods of the fiscal year than at any other time.

"We ask what's happening in those last five periods towards the end of the (calendar) year?" Groome said. "What you see is that the clocks go back, the clocks go forwards, you have the festive period. With information like this, it has enabled managers to be more on the 'front foot' when approaching seasonal patterns."

He said that TOL has discovered that fatigue events were more common on Mondays, Tuesdays and Wednesdays, particularly after a long weekend or a period of absence. They are more common in more low workload areas (out of town) and least likely in high workload (urban) settings, where drivers are on high alert for hazards. Stretches of tramway in out of town locations are more likely to trigger an event.

While the period when the clocks change is problematic, hot summer temperatures can also be disruptive to drivers' sleep behaviours, as the data has now revealed: "The Stadler [Variobahns] have air-conditioning in the cab ▶



▲ ABOVE: While TOL's Guardian helps to monitor for signs of driver fatigue, it's been complemented by a comprehensive training programme that highlighted the risks of fatigue and ways to combat it. TOL

▼ BELOW: Artificial light can play havoc with the body's circadian rhythms, and the period when the clocks change over can prove particularly problematic. Here at Amsterdam Centraal, night has fallen but the station remains busy. Drivers working changing shift patterns, particularly night-time shifts, can be prone to fatigue, and spotting these patterns raises questions that can help to improve driver wellbeing. Neil Pulling



► RIGHT: Data collected by TOL suggests that temperature can also play a role in fatigue events. The Costa Blanca seafront section north of Alicante is one such system where temperatures can reach 40 degrees C, but air conditioning in the cab can help to keep drivers alert. Neil Pulling

but the old Bombardier [CR4000s] don't, they have an air-cooling system," Groome said. "We started looking to see if we're getting a higher trend of activations within the fleet in the summer months. Most parts of the year is a 50/50 split."

Spotting patterns in the data raises questions that can often improve driver wellbeing. For example, a pattern of Guardian activations early in a shift, Groome said, provokes the question: "How is the wellbeing of the drivers when signing on, and timeliness of when they are signing on?"

A spate of fatigue events or time of day in relation to a particular duty enables TOL to study the positioning of breaks within that duty.

"The allocation team... have a critical role in making sure that they're allocating the right jobs to people," Groome said, "to ensure that we are doing our best to maintain fatigue-free allocation."

Having so much data to hand also enables complaints to be handled effectively. "When I am informed that a specific duty is potentially the cause of fatigue, I can point out that that duty hasn't had a Guardian activation on it in the last five years.

"I ask, 'does this say to us that the drivers are preparing themselves better for that duty, knowing that it's a harder duty?'"

An area for consideration is where a longer or harder duty is placed within a roster and the duties either side, and the data helps show where improvements could be made.

TOL is using the data it holds to build profiles of its drivers. Groome explained: "Within the last 12 months we have started using the data to build a dashboard. An example we identified was a driver with five activations within the last 12 months,



which have all been in the first half of the duty, and always before a break.

This level of insight helps to give our management team the opportunity to ask that driver if they're preparing themselves for work at the right time, doing things the correct way, following all the training. It enables our management teams to have a different type of conversation than perhaps they would have previously had."

Having a camera monitor your face while data about you is being collected might feel as though George Orwell's dystopian vision of Big Brother has become reality.

But, Groome emphasised: "There is no discipline associated with anyone being fatigued. It's never been and will never be used as a disciplinary tool."

What it is used for is to help remove barriers between managers and drivers. It's enabling managers to have honest conversations in order to help drivers cope better with the rigours of shift working and managing their wellbeing.

For example, Groome cited one case of a driver who reported fatigue after three days' leave.

"I wouldn't expect a driver to report being fatigued on duty having just had

three days off, so it's allowing us to have a conversation," he said. "You have to ask: are you preparing yourself in the right way prior to coming in? It's not just about having an early night's sleep the day before, it's perhaps about having an early night's sleep two days before."

The data we have from Guardian has had a positive side effect, in identifying untreated health conditions. "We have had a number of people that have been diagnosed with sleep apnoea, hyperactive thyroids and Type 2 diabetes, all as a result of triggering the Guardian many times," Groome said.

The success of TOL's Fatigue Management System, including the data received from Guardian, means that TOL is involved and supporting the RSSB in a project - including trials on Britain's national railway network where Guardian-like monitoring devices are being fitted in the cabs of freight locomotives and heavy rail vehicles. He is proud of TOL's involvement.

"Light rail," he said, "for the first time is trying to sway the future of something that's happening in heavy rail. I think that's something that we should all be proud of."

TAUT

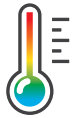
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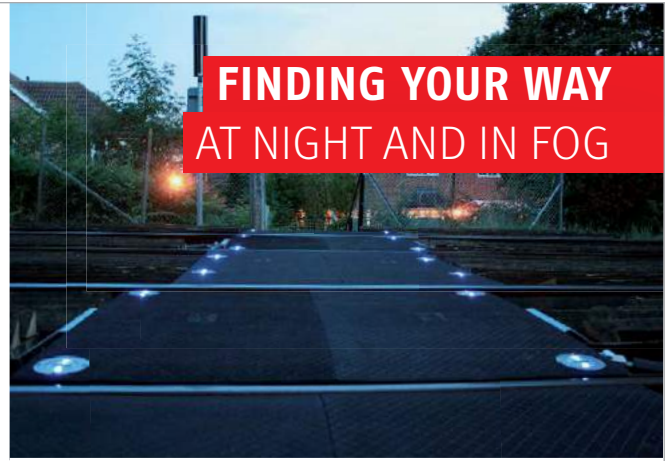
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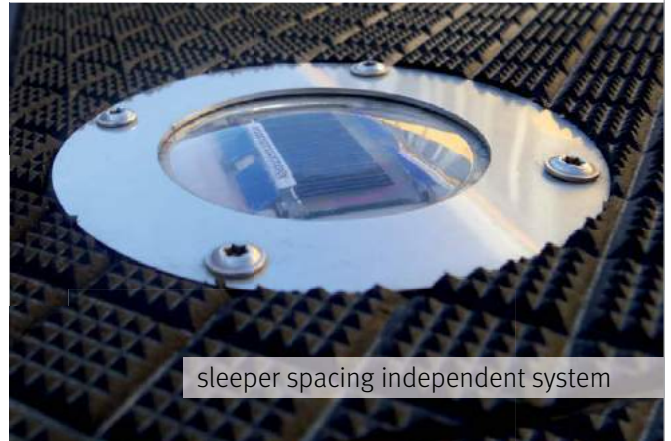
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**TRAMWAY
OPENINGS 2024**

Mike Taplin provides a round-up of the new systems and major expansion projects from around the world due to open to passengers in 2024.



**GERMANY:
RHINE-RUHR**

Public transport in Germany's industrial heartland is undergoing both contraction and expansion, as Andrew Thompson reports from the Rhine and Ruhr.



**SYSTEMS FACTFILE:
PARIS T4 & T9**

Neil Pulling samples two light rail operations extending into the outer suburbs of Paris, part of the expanding Île-de-France Mobilités network.

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BERLIN:

END OF THE CABARET?

Andrew Thompson reports from the German capital and its surrounds, where expansion is now followed by uncertainty.

All photos by Andrew Thompson, 3 November 2023 (unless stated otherwise)

In early September 2023, the 1.8km (1.1-mile) tramway extension from Berlin Hauptbahnhof to Turmstrasse opened in Germany's capital. It is served by the major trunk line M10 and serves three new intermediate stops, before terminating at the underground interchange Turmstrasse in the Moabit district.

Construction started in August 2021 and took about two years to complete; the whole project cost roughly EUR33m.

The extension serves one of the city's principal criminal courts at the namesake stop Kriminalgericht Moabit. This is symbolically significant as it takes tram tracks deeper into former West Berlin, where

in the early 1960s the decision had been made to abandon street-running trams in favour of buses and new underground lines. Indeed, the Moabit streets now served by a modern alignment already previously featured tram tracks, which were closed in stages from spring 1960 to autumn 1965. The new layout includes reserved formation and a good proportion of grassed tracks.

End-to-end journey times over the new extension are just seven minutes and M10 services operate at five-minute intervals during daytime and every ten minutes after 20.00; on Sundays and holidays headways are six or seven minutes. Initial projections are for 16 000 riders daily, with the extension

proving useful as a feeder to underground line U9 at Turmstrasse.

For Berlin the Moabit line marks the next tramway expansion after the 2.7km (1.7-mile) link from S-Bahnhof Schöneweide to Karl-Ziegler-Strasse opened in October 2021 to create a southeastern orbital route served by lines M17, plus 61 and 63. With this latest addition, the network currently has a size of about 194km (121 miles), solidifying its status as the largest in western and central Europe, although still being far from its former extent of 634km (394 miles) in 1930! Even with the new line in Moabit, the vast majority of Berlin's tram network is still centred on the city's former eastern zone.

▼ Running on line 61, *GT6N*1581 takes a left turn at the junction Schönweide/Sternsdamm and turns onto the track of the city's second-newest tram extension to Karl-Ziegler-Strasse, which opened in October 2021. Andrew Thompson, 21 February 2023



◀ LEFT: Running along the southeastern tramway extension, which opened between Schönweide/Sternsdamm and Karl-Ziegler-Strasse in October 2021, *GT6N*1604 arrives at Benno-König-Strasse with a line M17 service to Adlershof. Andrew Thompson, 21 February 2023



Mixed future picture

In spring 2023 a new centrist coalition came to power in Berlin's city senate. This is less ambitious about rapid tramway expansion than its left-leaning predecessor and instead favours measures to please motorists, while prioritising mid- to long-term projects for new *U-Bahn* or *S-Bahn* routes. While a number of small tram projects for optimised turnarounds or revamped turning loops are currently at an advanced planning stage and unaffected by the shift in political climate, more than a dozen projects for new-build tram routes have been paused and are due for re-evaluation. This includes such prominent schemes as the proposed tram route from Alexanderplatz via Spittelmarkt to Potsdamer Platz and from there on to Kulturforum, as well as the separate spur from Kulturforum via Kleistpark and Innsbrucker Platz to Rathaus Steglitz. In addition, the spur from Potsdamer Platz to Zoologischer Garten in the heart of western Berlin has been shelved pending further review. Originally slated to be completed by the end of this decade, these projects will not now be realised until the mid-2030s at the earliest, assuming they are delivered at all.

It's not all gloom though, as in early November 2023 the new city government approved the 6.2km (3.9-mile) western extension of line 60 from its current southern terminus at Haeckelstrasse near Schöneweide to Gropiusstadt in the Neukölln district of

▼ At the new Turmstrasse terminus, two of the long, double-ended *Flexity* LRVs that are deployed to offer sufficient capacity on the high-demand tram line M10 rub shoulders as they idle on the new stub track.





◀ **LEFT:** Running on Potsdam's newest tram extension, which opened between Viereckremise - Campus Jungfernsee in December 2017, the single-ended Siemens *Combino* 406 is about to call at Rote Kaserne with an inbound line 96 service. To the rear are the red brick buildings of the former military barracks, which give this stop its characteristic name. The tram is just coming off a roughly 250m single-track section along Nedlitzer Strasse, which is planned to be double-tracked as part of the first phase of the ambitious northern extension project to Neu Fahrland, Krampnitz and Fahrland.

Andrew Thompson, 21 February 2023

▶ Running inbound to Hauptbahnhof and then further east to Warschauer Strasse, *Flexity* 9153 turns away from the new stop at Kriminalgericht Moabit, which has been designed as an island platform in the middle of the street. To the rear are the twin towers and elegant portal of the landmark Moabit criminal court building from 1906.



former West Berlin. The new alignment is to run through the northern part of Rudow and then terminate in Neukölln at the busy Gropius Passagen shopping centre, which is also located next to the U7 underground interchange Johannisthaler Chaussee. Inauguration is planned by 2029.

In the same corner of the city, feasibility studies are currently being conducted for the extension of the same underground line U7 from its current Rudow terminus beyond city limits to the new airport BER at Schönefeld. As this extension would run through Brandenburg, both the Berlin city government and the state government of Brandenburg in Potsdam are expecting significant federal funding to the extent of 90% of project costs. Based on final route

selection, the cost is expected to be between EUR810m and EUR890m.

Previously ridiculed, BER international airport finally opened in October 2020, after originally being expected to be in public use by November 2011. The airport has a purpose-built main line railway station served by local, regional and inter-city trains. Regional services RE7 and RB14 provide a direct rail link via Berlin Südkreuz to Berlin Ostbahnhof and Berlin Hauptbahnhof, while lines S49 and S45 run on the roughly 340km (211-mile) dedicated Berlin *S-Bahn* network that draws power (750 V dc) from third-rail electrification. The latter includes the roughly 4km (2.5-mile) purpose-built spur from the former airport station at Schönefeld (now classified as Flughafen BER Terminal 5) to the new station at Terminal 1-2, with an intermediate stop at Wassmannsdorf.

Currently one of the most important *S-Bahn* extension projects is the planned re-opening of the so-called Siemensbahn between Charlottenburg and Spandau. Originally built from 1927-29, the 4.5km (2.8-mile) elevated line served the Siemens campus at Gartenfeld but was closed in 1980 after a strike by *S-Bahn* personnel. The branch diverges from the inner ring at Jungfernheide and serves the so-called Siemensstadt corporate campus, crossing both the River Spree and Berlin-Spandau Canal. While initial renovation works started in late 2020, the project is not expected to be completed until the end of the decade, with a currently envisaged reopening in autumn 2029.

Plans for future growth

East of Berlin, at the nearby separate tramway in the town of Woltersdorf (population 8500), the delivery of the first of three 15m *Moderus Gamma LF 10 AC BD* from Polish producer Modertrans is expected in the first half of 2024. Delivery is slightly delayed because of the ongoing ripple effects of the pandemic and Ukraine war.

These accessible vehicles will mark a paradigm shift for this tramway, which currently only operates high-floor vehicles from the days of the German Democratic Republic on the 5.6km (3.5-mile) line 87 from Rahnsdorf to Woltersdorf Schleuse.

West of Berlin in Brandenburg's state capital, Potsdam (population 186 000), the most recent tramway expansion dates from December 2017 when the 1km (0.6-mile) northern extension of line 96 from Viereckremise to Campus Jungfernsee opened. This serves a fast-growing residential area on the site of a former military barracks. By 2029 this branch is to be extended further north by ten stops and more than 7km (4.3 miles) to the growing districts of Neu Fahrland, Krampnitz and Fahrland, with an eventual terminus at Schule Fahrland. This should provide a roughly 30-minute journey time directly to Potsdam Hauptbahnhof.

Berlin's thoroughly integrated and attractively multi-modal public transport network remains a backbone of the city's quality of life – and is slated to keep pace with future population growth and the need to make urban mobility even more sustainable for locals and visitors alike. **TAUT**



▲ ABOVE: The newest vehicles on Berlin's underground network are the narrow profile type *IK*. These have been locally produced by Stadler at its Pankow plant from 2015-20, with 54 such trains delivered in four separate series. In February 2023, 1053 is seen at the overground terminus of lines U1 and U3 at the major interchange Warschauer Strasse.



▲ ABOVE: In mid-November 2023, the last of the Class 485 EMUs were withdrawn from service with *S-Bahn* Berlin. Originally their end of deployment was foreseen for the early 2000s, but a shortage of stock made them indispensable until the mass availability of the new Class 483 made them superfluous. In this now-already-historic picture from March 2016, a Class 485 unit is at the Spindlersfeld terminus of line S47, which was one of their last remaining routes right up to withdrawal.



▲ ABOVE: Running on the new extension, *Flexity* 9129 swings around the corner with an inbound line M10 service and is about to call at Alt-Moabit/Rathenower Str. The brick building to the rear is the large city gaol, which is part of the Kriminalgericht Moabit judicial complex and located behind the courthouse.



▲ ABOVE: Alexanderplatz remains one of the preeminent interchanges between Berlin's tram, underground and *S-Bahn* networks, including the recent 4km (2.5-mile) U5 extension to Hauptbahnhof, which opened in 2020 and integrated the previous, 1km (0.6-mile) short shuttle U55 from Hauptbahnhof to Bundestag.

► The new Class 483 EMUs are the modern stalwarts of *S-Bahn* Berlin. Although they are locally produced by Stadler at its Pankow plant, the electrical and braking components are supplied by consortium partner Siemens. The two-coach Class 483 is often combined with the four-coach Class 484 to create flexible, demand-based train formation lengths. The units have been in revenue service since 2021 and by 2023 their widespread availability has made it possible to finally withdraw the older Class 485. The initial rolling stock contract placed firm orders for 106 such EMUs, including 85 four-coach and 21 two-coach variants. In February 2023, a four-coach Class 484 leads such a formation at it arrives on the inner ring line at the major Ostkreuz interchange. The iconic water tower dates from the Prussian railway era and was built from 1909-12.



SYSTEMS FACTFILE

No. 196 Granada, Spain

Once the centre of a wide-reaching tramway network, Granada now has a new light rail system, which opened in 2017. Its success has led to expansion.

Words and pictures by Neil Pulling



The city of Granada, capital of Spain's homonymous province, has a population of around 230 000, with 550 000 in the metropolitan area. It lies at the western end of the Sierra Nevada mountain range and is about 360km (223 miles) south of Madrid. With a similarly high elevation to the capital but only 40km (25 miles) from the Mediterranean coast, Granada can have temperature extremes by the standards of southern Spain. The city's exotic identity was established long before the days of mass tourism. The name of its main historic site, Alhambra, adorned extravagantly-styled British theatres from Victorian times. Granada was the title of an internationally famous

song (written 1932), also becoming a name adopted by a British cinema chain and television company. Granada's economy relies significantly upon historical artefacts and an ambience which underpins the strong tourist trade. It also has a concentration of education, research and health institutions.

Granada is in Andalucía, the most populous of Spain's autonomous communities. The community's governing body, Junta de Andalucía, has supported 21st Century installations of urban light rail in several locations. Systems in Jaén and Vélez-Málaga have respectively not gone into normal operation and were suspended within six years of opening. Such a fate seems unlikely for Metropolitano de Granada (Metro),

▲ ABOVE: CAF Urbos 3 313 approaching Sierra Nevada on 5 October 2023. The heavily-used stop serves one of Spain's biggest shopping centres.

a tramway for which construction began in 2007; a 2012 opening target proved to be over-optimistic. When today's system opened throughout during September 2017, areas of largely complete infrastructure had lain unused for some years. Once into operation however, high patronage levels have supported expansion plans which are now being enacted.

The proportion of the 1435mm-gauge system's surface (83%) to tunnel (17%) locations on the 16km (ten-mile) route are almost the reverse of its closest active counterpart, Málaga (a separate entity to Vélez-Málaga).

Granada and surrounding communities had earlier tramway coverage that once totalled about 130km (81 miles). City services had used a metre-gauge system that grew

THE FLEET

Line 1 is operated by 15 bi-directional, air conditioned CAF Urbos 3 (301-315). With five sections, they are 2.65m wide and 32.3m long. Capacity is 221 with 54 seats, these of unpadded hard plastic. Anticipating the unrealised rather than the actual system opening, they were built 2012-13.

Similar to stock used in Malaga, the trams carry the Andalusian white and green colours, also used inside. The Junta de Andalucía name and emblem appears on cab ends. Service progress is represented internally on illuminated line displays. Possibly related to the greater street level visibility of Granada's trams compared to Malaga, many now have advertising wraps, some with window coverage which is very restrictive of views.

In 2022 an order for eight more CAF trams was announced, due for delivery in 2024. They are intended to allow for improved frequencies and to service the Las Gabias extension.



▲ ABOVE: The tram descends towards an underpass on revenue track between Cerrillo De Maracena and Maracena. One of the two depot access points is to the right.

▼ BELOW: The reconfigured forecourt of Granada's main railway station. The livery on tram 305 commemorates the sixth anniversary of the system's September 2017 opening.



◀ LEFT: This installation on Avenida de Andaluces acknowledges Granada's earlier years of widespread tram coverage.



▲ ABOVE: At some distance from central Granada, the well-used Estación de autobuses stop provides transfers with long-distance and city buses.





◀ LEFT: The terminus at Albolote, one of two stops in this municipality. It is projected to become the starting point of a northern extension to Atarfe.

to 13 lines. Electrically powered from the outset in 1904, these were ended by 1963. The rural Sierra Nevada route and interurban lines lasted for another decade. These operations are commemorated with a plaque 'in homage to the tram network 1904-1974 ... connecting past and future' and a short section of rails alongside today's tracks on Avenida de Andaluces.

Most of Metropolitano de Granada runs north-west to south-east, with a tangential coverage of the central area. It does not directly serve the densely-packed streets of the historic core, this mainly being the domain of pedestrians and buses. The Metro's routing around the centre's western edge is partly in a signal-controlled cut-and-cover tunnel that includes three stops. The tunnel passes beneath the Genil river near Alcázar Genil, a stop that was structured around and is used to display relics found during construction. The other two underground stops and the closest to the city centre, Recogidas and Méndez Núñez, are respectively the most heavily-used on the system. Nearer the southern end, tracks turn west to end in Armilla, one of four municipalities currently covered by the service.

The route includes two main transit points, both of which predated the metro. Heavily-used due to the significance of long distance bus services in Spain, Estación Autobuses stop is immediately outside Granada's terminus. The counterpart at the main railway station was more complex and

required repurposing land controlled by Spain's rail infrastructure body, Adif. Buildings were demolished and sidings were removed for tram access and to provide space for Estación de ferrocarriles stop. Completed during summer 2016, these works also improved pedestrian and cycle access for a nearby university campus.

Other high traffic generators include hospitals, educational sites, the football stadium and an adjoining sports centre. The stop next to one of Spain's biggest shopping complexes, Nevada Shopping, is the third busiest.

The system's surroundings overall are varied, with areas around the two termini and along a main road in Maracena exemplifying mature settings pre-dating the Metro. In contrast, there are modern residential districts which are clearly contemporary with the system's development. Elsewhere land remains near the tracks, which appears destined for more intensive use.

Tram operations began with and remain contracted to a special purpose subsidiary of the Mobility ADO group, Avanza Metro de Granada. Since taking over Transportes Rober in 2021, franchised city bus lines are run by Alsa (Mobico, formerly National Express Group), an Avanza rival in long-distance services. The Metro service is designated Line 1, usually running end-to-end between termini with a 47-minute journey time. Frequencies vary from late/early 15-minute intervals (30-minute



▼ BELOW: The three underground stops have a common configuration, including island platforms and barrier access on a mezzanine level.



◀ LEFT: Armilla terminus, starting point of the forthcoming first Metro extension which will run to Las Gabias municipality.



◀ LEFT: Artificial grass is widely used across the system, as on this wire-free section on Avenida de la Constitución between Caleta and Villarejo.

NETWORK FACTS

- > **Opened:** 2017
- > **Lines:** 1
- > **Length:** 16km (ten miles)
- > **Stops:** 26
- > **Depots:** 1
- > **Approx. weekday hours:** 06.30-23.00
- > **Line frequency:** Varies by time bands
- > **Gauge:** 1435mm
- > **Power:** 750V dc overhead and stored energy
- > **Fleet:** 15 (plus eight on order)
- > **Operator:** Avanza Metro de Granada
www.metropolitanogranada.es
- > **Civic information:** www.granada.org
and www.juntadeandalucia.es
- > **Tourist information:** www.andalucia.org/en/provincia-granada



▲ ABOVE: Méndez Núñez, one of three stops on the Granada system's approximately 2.7km (1.7-mile) underground section.

▼ BELOW: Modern buildings characterise the area between Jaén and Cerrillo De Maracena stops.



“Overhead line sections predominate, with several separate wire-free stretches.”



weekends) to eight minutes during peak times. During peaks in the central section, trams can be overloaded to the point of people being unable to board. Services run to 02.00 on Friday, Saturday and evenings before public holidays, also with modifications in relation to events that attract crowds.

In a manner widely used on modern Spanish tramways, grooved rails are set in concrete, with the appearance softened by textured paving or artificial grass. The many road intersections include tracks which pass through roundabouts. Apart from the underground sites, the stops have a common format, with substantial short shelters including ticket machines, seating, service displays and etched line diagrams on tall panels topped with the Metropolitano logo. Unlike the otherwise well-kept and stylish facilities, the cut-out letters on signage seem prone to losing their centres. The three underground stops feature island platforms, barrier control on a mezzanine level and provision for access from both ends, although one of each pair may be restricted to emergency use. Currently used only by single 33-metre trams, platforms across the system could accommodate double lengths.

The tram fleet is equipped with CAF's ACR system for the fast charging of roof-mounted supercapacitors. Overhead line sections predominate, with several separate wire-free stretches. One of these is on the only single-track section which takes narrow streets on the approach to Armilla terminus, also being atypical by having shared road space. The depot site that includes the system's administration and control centre is located just away from revenue tracks.

There is access from both directions, with junctions between Cerrillo De Maracena and Maracena stops.

The Junta de Andalucía's 2021 document *Informative Study for Expansion of the Granada Metro* covers intentions up to 2030. The first extension with a potential opening in 2026 has been approved. It will bring coverage to two municipalities, Churriana de la Vega and Las Gabias, adding almost 6.8km (4.3 miles) and six stops west from Armilla terminus. A northern extension would add 5km (3.1 miles) and five stops between Albolote and Atarfe. Both would include some single-line sections.

A more challenging if potentially well patronised addition would take a key central road axis through commercial and tourist areas. Surface-running track with seven stops is planned over 3.5km (2.2 miles) between the existing Caleta and Andrés Segovia. Recasting services to integrate the new and existing infrastructure could lead to three lines being implemented. Becoming the system's longest, Line 2 would add the northern and southern extensions to line 1 coverage, but would instead take the new central route. Line 3 would be a central service over a circuit enabled by the two central routes.

Supplementing Metro expansion, a Granada-centred Renfe Cercanías (suburban/commuter) railway service is proposed, providing a more frequent and high capacity service at stations around the metropolitan area. **TAU**

◀ **LEFT:** The longest of four wire-free sections includes single-track access to the centre of Armilla.

▼ **BELOW:** The ramp between the surface-sited Universidad stop and in-tunnel Méndez Núñez.



ESSENTIAL FACTS

Local travel: Ticketing by value added to rechargeable cards, these in two formats according to intended use. More relevant to visitors, flexible cards for up to one year's re-use at EUR0.30 or rigid cards at EUR1.80. Ticketing specific to the Metro: 90-minute validity for EUR1.35; Tarjeta Turística 1 Día (one-day tourist card) at EUR4.50. Tickets bought and recharged at multi-lingual machines at each stop. Validation required aboard trams and at barriers in the underground stops.

What is there to see? At the foot of the Alhambra, the warren-like historic centre radiates from Puerta Real de España, which is 600 metres north-east from Recogidas Metro stop. There are tourist offices just west of the cathedral and at City Hall on Plaza del Carmen. Although the old centre is most suited to walking, minibuses - indicative of the narrowness of some streets - connect with upper levels, as detailed on <https://granadainfo.com>. A legacy of a Moorish Islamic presence on the Iberian peninsular across seven centuries, the Alhambra site's many facets are described and ticket options are given at www.alhambra-patronato.es.

Worldwide Review

AUSTRALIA

STIRLING, WA. This suburb of Perth inaugurated a trial around the Farmers Market car park with a CRRC 'trackless battery tram' on 26 November. The 'tram' uses digital guidance and, if deemed successful, the city plans to use them on a line from Glendalough railway station to Scarborough Beach.

stirling.wa.gov.au

SYDNEY, NSW. New CAF Urbos 100 2125-28 entered service on Line L1 on 8 December. They are presently being used for driver training.

transphoto.org

AUSTRIA

SALZBURG. A non-binding referendum on 26 November resulted in 58.3% of voters rejecting plans to extend the Lokalbahn under the city centre to the southern suburbs. There is concern at the high cost and the effect on taxes.

ORF

WIEN (Vienna). The 'ground-breaking' ceremony for the EUR1.1bn (GBP949m) *S-Bahn* modernisation project took place at Henselskai on 23 October. The line between Praterstern and Floridsdorf will be closed between the summer of 2024 and 2025 and will be replaced by a tramway. In 2026, the focus of work will move to the *Nordbahn* and from that September to October 2027, there will be no service between Praterstern and Hbf.

BELGIUM

BRUXELLES (Brussels). PCC 7700 Series six-axle cars can still be seen on Lines 39, 44, 93 and 97, with a peak run-out of 35 cars. Of the new low-floor trams, just 3201-03/05-09 had arrived by early December. Five are in service on Line 51.

BOLIVIA

COCHABAMBA. The Red Line has been extended closer to the city centre, reaching Estacion Antigua San Antonio. At the other end of the Red Line, a 2.8km (1.7-mile) extension to Uspaha-Uspaha is under construction.

UTM

CANADA

QUÉBEC CITY, QC. Plans for a 19.3km (12-mile) tram line are on hold because the only consortium left in the tendering process for the construction contract has withdrawn. Costs have risen from a projected CAD3.3bn (EUR2.3bn) to CAD13bn (EUR8.9bn). The province, which had promised 50% financial support, had commissioned CPDQ Infra



▲ Gera in eastern Germany has ordered TINA trams from Stadler, that will match those supplied to Darmstadt. Stadler

to assess current and projected transport needs, considering all transport modes. Alstom had already been selected to supply 34 *Citadis Spirit* trams.

DS

MISSISSAUGA, ON. The first of 44 LRVs for this line was on test at Alstom's Kingston site in November. It is the same design as the Alstom cars delivered to Ottawa. Passenger service is likely to launch in the first quarter of 2025.

D.Drum

CHILE

SANTIAGO. The 5.2km (3.2-mile) four-station southern extension of metro Line 2 from La Cisterna to Hospital El Pino was opened on 27 November.

urbanrail.net

CHINA

BEIJING. A collision took place during heavy snowfall between two metro trains on a surface section of the Changping line between Xi'erqi Station and Life Science Park on 14 December. The incident left 150 passengers hospitalised.

BBC

CHENGDU. Suburban orbital metro Line 19 was extended by 43.2km (27 miles) from Jiujiang North to Tianfu Station on 28 November. At 561.7km (349 miles), this is now the world's fourth-largest metro system behind Shanghai, Beijing and Guangzhou.

urbanrail.net

CHONGQING. Two metro openings took place on 30 November: the 4.7km (three-mile) extension of Line 5 from

Dasiba to Shiqiaopu and the 3.8km (2.4-mile) extension of Line 10 from Houbao to Lanhuala. The 29km (18-mile) Line 18 opened from Fuhualu to Tiaodengnan on 28 December.

urbanrail.net

GUANGZHOU. Trials started on the 22km (14-mile) metro Line 7 second phase on 28 November as well as the eastern 9.8km (six-mile) extension of Line 5. Regular operation should have started by the time this issue is published.

news.dayoo.com

GUIYANG. The 43km (27-mile) metro Line 3 from Luwan to Tongmuling opened on 16 December 2023.

skyscrapercity

HARBIN. Metro Line 3 was extended by 800m from Chinese-baroque Block to Beima Rd on 26 December.

urbanrail.net

HEFEI. Two metro line extensions opened on 26 December: the 14.5km (nine-mile) Line 2 extension from Sanshibu to Cuozhen and the 9.5km (six-mile) Line 3 extension from Xingfuba to Sheng Ertong Yiyuan Xinqu.

urbanrail.net

MACAU. The 3.3km (two-mile) Taipa LRT extension from Oceano to Barra opened on 8 December. This included the 2.2km (1.3-mile) Sai Van bridge to the Macau peninsula.

skyscrapercity

NANTONG. Passenger services started on the 20.9km (13-mile) Xingfu - Xianfeng metro Line 2 on 27 December.

urbanrail.net

SHENZHEN. The 8km (five-mile) metro Line 8 extension opened from Yantain Road to Xiaomeisha on 28 December.

sz.gov.cn

WUHAN. Metro Line 5 was extended by 2.6km (1.6 miles) from University to Hongxia on 1 December.

urbanrail.net

ZHENGZHOU. The new 16.5km (ten-mile) Lianghu - Longzihu Dong metro Line 12 opened on 20 December.

urbanrail.net

CROATIA

ZAGREB. The first of 11 GT6M low-floor articulated trams purchased from Augsburg arrived in early December. Ex-Augsburg 607 arrived in ZET's blue livery with its new number, 1001.

UTM

ECUADOR

QUITO. Services on the 22.6km (14-mile) metro Line 1 started on 1 December. It had been 'inaugurated' in December 2022, but has not run since 11 May 2023. The 18 CAF-built six-car trains carried some 273 000 passengers on the first three days.

skyscrapercity

EGYPT

EL QAHIRA (Cairo). Testing of the 56.5km (35-mile) East Nile monorail started in November. It is due to be handed over to the operator in April 2024.

RGI

FRANCE

CAEN. The first of ten new Alstom *Citadis* trams was delivered on 13 December. They will be used to reduce the headway on Line 2.

lineoz.net

LE HAVRE. The January 2024-December 2029 operating contract for the Lia network has



▲ The double-ended version of the Bombardier-designed Alstom trams for the German city of Dresden can now be seen in service. Car 2987 is at Merianplatz. Lukas 942

been awarded to the incumbent Transdev. A third line will be built during the contract. *lineoz.net*

LILLE. The formal contract with Alstom for the supply of 24 32.4m *Citadis* vehicles (with an option for a further six) was signed on 20 December. *lineoz.net*

MONTPELLIER. Free public transport for residents who hold a residential pass was introduced from 21 December. *lineoz.net*

PARIS. Line T12 opened on 11 December. The 25 Alstom *Citadis Dualis* 42m tram-trains maintain a 12-minute service at peak times (every 30 minutes off-peak). One quirk is left-hand running on the former rail section and right-hand running on the tramway section. Alstom has been awarded a EUR300m (GBP259m) contract to install its CBTC train control system on RER Lines B and D in 2031-33. *RGI*

GERMANY

BERLIN. Tenders are being evaluated for the planned 134.7km (84-mile) Line M41 from Schöneweide Bhf to Potsdamer Platz via Baumschulenweg. It will replace an overcrowded bus route but is unlikely to be completed before 2035.

Driver training was to start in January on the first of 140 new Stadler small-profile *U-Bahn* trains. *Berliner-Zeitung*

BRAUNSCHWEIG. Tram services on Lines 3 and 5 were suspended from 27 November until early December due to flooding. *DR*

BREMEN. Just 11 *GT8Ns* remained in passenger service by the end of December: 3007/11/24/33/42/55/57/60/62/64/72.

While 3017 and 3076 are used for driver training, 3073 is destined for museum purposes. *DS*

FREIBURG/BRSG. Tram 318, the first of a third batch of CAF *Urbos*, entered service on 9 December. *S. Rosen*

GERA. GVB signed a EUR38m (GBP33m) contract with Stadler on 11 December for six new 43m *TINA* low-floor trams. Delivery will start in 2026. They will replace Tatra *KT4Ds*. *DS*

HALLE/LEIPZIG. Siemens has been awarded a EUR500m (GBP431m) order for 75 Mireo *S-Bahn* trains for the central German network that serves these cities. Battery EMUs will run on LineS1 in order to connect Grimma and Döbeln to the system. *IRJ*

JENA. The 1.1km (0.7-mile) tramway extension from Zwätzen to Himmelreich (Carl-Orff-Strasse) is to go ahead following receipt of a EUR31.4m (GBP27m) federal grant. The first of 16 new Stadler *Tramlinks* entered service on 16 December. *UTM*

NÜRNBERG (Nuremberg). Further to the report in *TAUT*1033, Lines 10 and 11, introduced from 10 December, are new routes. *UJM*

STUTTGART. Staatsgalerie subway station re-opened on 26 December. This has allowed the heritage line (21) to the museum to resume after seven years. *DS*

WOLTERS DORF. It is understood that the order for three new trams from Modertrans could be increased to four. Delivery is expected in March 2024. *DS*

WUPPERTAL. Schwebbahn service had to be suspended on 1 December when two sloths were discovered hanging from the tracks between Wupperfeld and Oberbarmen. The sloths were removed by the fire brigade. *der-postillon.com*

INDIA

KOLKATA. The first 5.4km (3.3-mile) section of metro Line 6, from Kavi Subhash to Hermanta Mukhopadhyay (Ruby) opened on 24 December. *urbanrail.net*

IRAN

TEHRAN. Suburban commuter rail Line 1 was extended by



▲ Withdrawn PESA low-floor trams in Moskva's Krasnopresnenskova depot on 4 December 2023. Kalita

19km (12 miles) from Imam Khomeini International Airport to Shar-e Parand on 30 November. *urbanrail.net*

IRELAND

DUBLIN. *Citadis* 5037 suffered fire damage on 23 November when it was caught up in disturbances in O'Connell Street that also destroyed shops and a number of buses. Luas and Alstom are assessing the damage. The overhead catenary also suffered damage, which required revisions to service.

ISRAEL

TEL AVIV. The Alstom-led TMT consortium signed the contract to design, build and maintain the 39km (24-mile) Green Line light rail project on 17 December. It will supply 98 trams based on Alstom's *Citadis* XO5. The system is due to open in 2028. *RGI*

ITALY

BOLOGNA. The EUR272.2m (GBP235m) contract to build the first 6.9km (4.3-mile) section of the Green Line tramway between Corticella and the city centre has been awarded to the Alstom-led CMB consortium. Construction is planned for 2024-26. *RGI*

NAPOLI. CAF has delivered the first of ten six-car metro trains to EAV for the 10.5km (6.5-mile) Metro Campania NordEst Arcobaleno line from Piscinola Scampia to Aversa Centro. *RGI*

MALAYSIA

JOHOR BAHRU. The Iskandar Development Authority and Johor Public Transport Corporation have submitted plans for a three-line light rail network totalling some 30km (19 miles). *RGI*

MEXICO

MONTERREY. CRRC Nanjing Puzhen has unveiled the first of 13

six-car automated monorail trains that are on order for Mexico's first monorail network. The system comprises the 7.5km (4.6-mile) Line 4 and 9.1km (5.6-mile) Line 6. Both are due to open in time for the 2026 FIFA world cup. The planned Line 5 has been scrapped in favour of bus rapid transit. *RGI*

NETHERLANDS

AMSTERDAM. The default speed limit for motor vehicles on city streets became 30km/h (19mph) from 8 December. Trams, on segregated track, can travel at up to 50km/h (31mph). *TP*

NORWAY

TRONDHEIM. A tender is being prepared for up to eight new low-floor trams, for delivery in 2027-28. *UTM*

PERU

LIMA. The 5km (three-mile) underground Evitamiento - Mercado Santa Anita section of metro Line 2 opened on 21 December. Services are operated by five Hitachi Italia six-car EMUs. *urbanrail.net*

PHILIPPINES

MANILA. Seven eight-car EMUs have been ordered from CAF under a contract worth PHP9.1bn (EUR150m). They will be used on limited-stop services on the future north-south commuter rail line. *RGI*

POLAND

KATOWICE. Line 25's 600m Dab Huta Baildon - Dabrowski extension opened on 22 December. Repairs are being carried out on the last 600m of the Sosnowiec tramway to Kamierz. Services have been suspended since October. *TP*

KRAKÓW. Tenders have been issued for 90 new 100% low-floor trams - some 32-34m long and some 42-45m - to replace



▲ Last month's story about 200 new Skoda trams for Praha (Prague) has now been followed by a digital impression of the car. Skoda



▲ Zaragoza 3230 is the first of two new CAF Urbos trams delivered to the Spanish city. CAF

high-floor trams by 2026. Swivelling bogies are required and one will be trial-fitted with batteries. If successful, a further 29 will receive batteries. *TP*

ŁÓDŹ. Two of ten 1995 AEG low-floor trams from the German city of Jena were delivered on the night of 11/12 December. Meanwhile, Modertrans has completed the delivery of *Moderus Gamma* trams 2341-79. *DS*

POZNÁN. Services resumed on the Kórnik line after complete modernisation on 16 December.

WARSZAWA (Warsaw). PLN90m (EUR21m) has been allocated to start work on the design of a third metro line. The 8.1km (five-mile) line will link Goclaw and the National Stadium.

Tram tracks from the ghetto period were uncovered in Przyokopowa on 29 November. They will go on display at the Warsaw Rising Museum. The last Russian-built *81 Series* metro train ran on 28 November. Three are destined for Kharkiv in Ukraine if transport can be arranged. *TP*

PORTUGAL

PORTO. The first of 18 CRRC Tangshan-built light rail vehicles entered passenger service on 6 December; 15 have been delivered. The annual museum tram parade is to take place on 4 May. *viva-porto.pt, M. J. Russell*

RUSSIA

KOLOMNA. The city celebrated 75 years of its trams in November. Its All-Russian Vocational Competitions for the Best Tram Driver attracted 39 entrants from 27 systems and it was won by a Kolomna driver. *N. Semyonov*

KURSK. PKTS in Sankt Peterburg has started to deliver three 79-911 *Lyonok* bogie trams. *transphoto.org*

MOSKVA (Moscow). Newly re-elected Mayor Sergei Sobyenin has announced an increase in public transport fares as well

as a plan to refurbish the city's monorail. The fleet of 70 PESA 71-414 *Fokstrot* trams is out of use due to the inability to obtain spare parts from Poland. The last Tatra T3, 30189, is now displayed outside Kurskaya metro station. Lines 14, 26 and 47 were suspended for two weeks in October to permit a new track fan at Apakov depot to be connected. *transphoto.org, N. Semyonov*

ORYOL. The rebuilt Red Bridge along the main city artery re-opened on 1 December, permitting the return of Lines 1 and 3. Line 4 to the railway station is suspended due to poor track conditions. *transphoto.org*

SANKT PETERBURG (Saint Petersburg). Uraltransmash has delivered the first two-section 71-421R *Dovlatov* low-floor retro look tram. Car 3800 will work from Depot 3. Three-section retro 71-431R *Dostoevsky* trams are already in service.

SARATOV. Six 71-628 trams have been ordered from PKTS in order to modernise Line 9. *transphoto.ru*

YAROSLAVL. A tramway concession has been awarded to Movista Regions. It has ordered 47 71-628 100% low-floor bogie cars from UKVZ for delivery by 2025. *RGI*

YEKATERINBURG. Line 1 services on the new 4.2km (2.6-mile) line to Akademicheskii district started on 23 December. Services are mostly worked by Tatra T6B5SUs that date from 1988. *N. Semyonov*

SOUTH KOREA

SEOUL. Commuter rail Line 1 was extended by 17.8km (11 miles) from Soyosan to Yeoncheon on 16 December. *urbanrail.net*

SPAIN

ZARAGOZA. The first of two new CAF trams (3230) was unveiled on 11 December. *RGI*

SWITZERLAND

BERN – SOLOTHURN (RBS). The tender for up to 20 three-section 60m units was published on 6 December. *bahnonline.ch*

CHUR – DISENTIS (RhB). Heavy snowfall caused disruption to the network on 2-3 December. *bahnonline.ch*

THAILAND

BANGKOK. The city administration has transferred responsibility for the Grey Line monorail, Silver Line LRT and Skytrain Green Line from Bangkok Metropolitan Administration (BMA) to the Mass Rapid Transit Authority (MRTA). *skyscrapercity*

UKRAINE

KHARKIV. Restoration of the tracks along Mironositskaya for Line 12 is underway. Work is expected to be complete by 1 December 2024. *transphoto.org*

KYIV. Metro traffic was suspended between Lybidskaya and Teremki stations on 8 December when cracks were discovered in tunnel linings. Replacement buses with a one-minute headway are running. Repairs may take six months. *TP*

MARIUPOL. Tatra T3 trams were transferred to Horlivka in occupied Ukraine, in December, to replace *KTM-5s*. *transphoto.org*

ODESA. Delivery of new Tatra-Jug *KIT* low-floor vehicles started with tram 306 on 20 December. *transphoto.org*

UNITED ARAB EMIRATES

DUBAI. Construction of the 30km (48.2-mile) metro Blue Line started on 24 November. Half the line will be underground and services are due to start in 2029. Tenders have been invited for 28 trains.

UNITED KINGDOM

LONDON (TRAMLINK). Transport for London has issued

a tender for the supply of 24 new trams (with options for a further 16), to replace aging *CR4000* vehicles on the Croydon network.

The 30-year supply and support contract, applications for which will close in February, is valued at GBP385m, with the new fleet expected to contribute towards TfL's 'Vision Zero' aim.

LONDON (UNDERGROUND). Colindale and Leyton Underground stations will be rebuilt with step-free access, after the UK Government confirmed Levelling Up funding totalling £43.1m (EUR49.7m).

Work is to start at Colindale in the spring while the contract to rebuild Leyton is to be awarded during the summer. The Planning Inspectorate is to allow the entrance to South Kensington's Underground station to be redeveloped. The transformation will include new housing as well as provision for step-free access to the District and Circle Lines. The planning application had been rejected by Kensington & Chelsea Council.

The council has also rejected calls by London's community of kohanim Jews for a secondary roof at South Kensington to form a barrier between the station and the human remains that form part of the Science Museum's collection. Kohanim cannot be under the same roof as a corpse and the proposed roof would create "a physical separation from the museum, which would satisfy rabbinic legal requirements".

SOUTH WALES. Quakers Yard railway station, on the Merthyr Tydfil-Abercynon line, re-opened on 18 December. The line through the station has been restored to double-track and a second platform has been opened. The work forms part of the South Wales Metro project. Transport for



▲ 23 December was the first day of operation of new tramline 1 in the Russian city of Yekaterinburg, with Tatra T6 367 of 1988 seen in this view. N. Grigoriev

Wales has committed to retaining guards on all its trains, including the new Stadler tram-trains to be used on the South Wales Metro.

STOURBRIDGE. Pre Metro Operations, which operates the Stourbridge Town – Stourbridge Junction line, has joined forces with Oakham Research to conduct a further public consultation on its plans to return passenger services to the freight-only route from Stourbridge Junction to Brierley Hill. The proposed ‘Dasher’ service would make a connection with West Midlands Metro.

TYNE & WEAR. Nexus, operator of the Tyne & Wear Metro, has started restoration work on the 1910-built trainshed at Whitley Bay. All the metalwork on the Grade II listed structure will be restored and the glazing replaced. The multimillion-pound project is due to be completed in 2025.

A permanent cast of Sir Mo Farah’s footprints has been officially unveiled at South Shields Transport Interchange, celebrating the athlete’s achievements in the Great North Run.

WOLVERHAMPTON.

Passengers on West Midlands Metro have been warned that overnight work at tramstops might cause disruption during the day. The work at The Royal, Priestfield and The Crescent stops started on 4 December. It is part of a scheme to install infrastructure that MD Sophie Allison said will “pave the way for new technology, including future ticketing systems”.

USA

BOSTON, MA. MBTA closed the Green Line between North Station and Kenmore 28 November-5 December for track work, while there were

night-time closures until 17 December between North Station and Medford/Tufts. North Station and Union Sq. Kenmore – Riverside were closed 11-20 December. The B branch between North Station and Babcock St and the E between North Station and Heath St, as well as the C and D branches between North Station and Kenmore, are to be closed in January for work.

Mass Transit

CHICAGO, IL. The report into the collision between a Yellow Line train and a snow removal machine on 16 November indicates that the passenger train was unable to brake in time due to slippery rails.

Mass Transit

DETROIT, MI. RTA is evaluating whether to take over direct management of the QLine tramway from M-1 Rail.

Mass Transit

NEWARK, NJ. Newark Liberty International Airport has awarded Doppelpmayra USD570m (EUR520m) contract to design, build, operate and maintain a new shuttle service that will replace the current 4.8km (three-mile) AirTrain monorail.

NEW YORK, NY. Kawasaki Railcar Manufacturing delivered the first R-211 subway cars (100-104) to the Staten Island line in the autumn of 2023.

ERA

PHILADELPHIA, PA. PATCO has started to refurbish Franklin Square station, closed since 1979, so that it can be re-opened later this year.

J.May

PHOENIX, AZ. Services on the 2.6km (1.6-mile) Northwest Extension Phase II are due to start on 27 January 2024. It links 19th Ave/Dunlap to Metrocenter in the West Valley, where there is a new park-and-ride facility.

J.May

SACRAMENTO, CA. Electrical ‘burn-in’ testing of the 28 new

Siemens S700 LRVs started on 7 December. They are due to enter passenger service in spring 2024.

Mass Transit

ST LOUIS, MO. Siemens Mobility is to supply 24 new S200s, with an option for 31 more, in a deal worth USD390.4m (EUR356m). The 25.8m two-section LRVs will not only start to replace the system’s 31 1993-built LRVs but will be used on the new 8.3km (5.2-mile) extension to MidAmerica St Louis Airport, which is due to be finished in 2025.

Mass Transit

SAN FRANCISCO, CA. BART and Muni transit agencies will receive state and regional financial aid through to 2026 in order to avert drastic service cuts. They will receive 45% and 40% respectively of the USD776m (EUR708m) funding, with the remainder being allocated to Golden Gate Transit, AC Transit and Caltrain. BART will use the money to replace its 715 fare gates with versions designed to deter rampant fare evasion.

San Francisco Chronicle

SEATTLE, WA. Sound Transit board has approved introduction of a USD3 (EUR2.73) flat fare on light rail from autumn 2024. This is to coincide with the Northgate – Lynnwood extension opening.

J.May

WASHINGTON, DC. WMATA released details of its planned FY2025 budget with a USD750m (EUR684m) shortfall to be addressed by unprecedented service cuts, including extended headways, an early shutdown and station closures on the metro.

As a first step to returning more 7000-series metro cars to service, WMATA has started to replace all wheels at the rate of 20 cars/month. Automatic door operation was introduced on the Red Line from 5 December.

R.Barrows

VIETNAM

HO CHI MINH CITY (Saigon). Public service on the new 19.7km (12-mile) metro is now predicted to start in July 2024, 12 years after construction started.

skyscrapercity

MUSEUM NEWS

CAMPINAS (BR). It is hoped that repairs will enable operation of the circular tourist tram line in Parque Taquaral to resume in January. Last year’s operation was suspended after a eucalyptus tree fell across the track, bringing down overhead wire. In the meantime all four cars are in the depot: 2 and 4 are operational but 1 and 3 have had bogies removed.

M.J.Russell

CIESZYN (PL). A replica of two-axle 1911-built car 4 has been

installed next to the cross-border tourist information centre at the Friendship Bridge.

TP

FLEETWOOD (UK). A scheme to create a tram museum has been abandoned. Metro-Cam Twin Set 673+683 has moved from the Wyre Dock compound while Brush railcar 637 has been scrapped.

HUDSON-BERGEN (US). Public Service bogie tram 2651, built in Newark in 1917 and retired in 1940, has been cosmetically restored by the North Jersey Electric Railway Historical Society. The repaint was sponsored by Kinkisharyo International.

njerhs.org

KENNEBUNKPORT (US). The latest arrival at the Seashore Trolley Museum is Toronto CLRV 4068.

Seashore Trolley Museum

MÖNCHENGLADBACH (DE). Düwag articulated tram 26, built in 1957, has returned to its home city for the first time in 46 years. It has been restored to original condition, but a location for its display has yet to be decided.

tw26.de

MOSKVA (RU). The Transport Museum at 27 Ulitsa Novoryazanskaya (halfway between Komsomolskaya and Baumanskaya metro stations) has a metro section that displays 1927-built Orenstein & Koppel set 106. This was built for Berlin but sent to Moskva (Moscow) as part of war reparations in 1947.

N.Semyonov

SAN FRANCISCO (US). The Market Street Railway is buying ex-Blackpool ‘Boat’ 226 from the Western Railway Museum. ‘Boats’ 228 and 233 are already operating in San Francisco.

BTOL

CONTRIBUTORS

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MAILBOX *Get your views into print*

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Letters submitted by post should be clearly typed and preferably not handwritten. We reserve the right to edit contributions for publication.

A Swedish solution for the Manx heritage railway?

The article in the January edition of *TAUT* (1033) suggests concern for the future of the northern part of the Manx Electric railway, with possible singling between Laxey and Ramsey. I wonder if there may be potential for some form of commercial passenger service on both this route and the steam railway, since these routes combined run pretty much along the length of the island and serve many of the main centres of population.

Currently, the bus is the 'heavy lifter' in terms of real public transport on the island, with the railways offering only a tourist attraction. This provides less security, since tourism demand varies with the vagaries of the economy. When budgets are tight, 'nice to haves' are inevitably sacrificed in preference to public services deemed more important.

Obviously, any such commercial operation would require suitable vehicles and new build would rule out any such speculative venture. With its 914mm gauge, little useful second-hand equipment is available to test a service at low cost. However, the Roslagsbanan in Stockholm is currently replacing its *X10p* EMU fleet. These vehicles, built by ABB/Adtranz between 1988 and 1995 are 891mm gauge,



▲ ABOVE: Might the *X10p* fleet (as shown here on the branch to Näsby park in 2022) from Stockholm's Roslagsbanan help provide a solution for the Manx Electric Railway's problems?

Phil Richards / CC BY-SA 2.0 DEED

so potentially adaptable to 914mm gauge relatively simply. They were refurbished about ten years ago and present a modern image. They work as three-car units, with a double-ended motor car and two trailers, so present flexible operating possibilities. They even have the driving controls on the 'UK' side of the cab!

Being 1500V dc, they would require adaptation to the MER's 550V dc, but

with the addition of batteries could potentially also be used on the Steam Railway route south of Douglas. I'm sure there may be issues that will rule this out (axle weight, loading gauge etc), but I wonder if it would be worth exploring further? These units are unlikely to find any other home due to their unusual gauge, and when they're gone – they're gone!

Mike Lipscomb, by e-mail

Control is a matter of safety

I must say I strongly disagree with the letter from Richard Youl in the last *TAUT*.

I spent over 30 years in a UK railway control environment before I retired, so I have experience in this matter.

Firstly, in the old days control rooms did exist. Late running trains and incidents were reported by the signaller and station staff. Passengers often had no idea where the train was though, especially at smaller stations.

Tramways had inspectors to do the job of a control room, but often couldn't see the big picture, and that is key.

Furthermore, there were often accidents and vehicles running about in unsafe conditions which just would not be tolerated today. And yes, sometimes there were power

cuts or a derailment at a crucial junction affecting the whole system, but tram crews and passengers sat in a big queue of traffic in Manchester or Glasgow had no way of knowing what was going on.

Furthermore, minor incidents and occurrences were often unrecorded, so trends in maintenance (etc) were not spotted.

So yes, control rooms are very much essential in today's very different world.

Colin Brazier, by e-mail

Some notes on Wien

With regards to Andrew Thompson's Factfile on Wien: It's a great article, I feel flattered to live in this city. I have two remarks:

1. Re the *ULF*'s low entry height – "well-suited, where street boarding without the use of platforms is common".

Well, there are fewer than ten stops left (out of 100s or even 1000s), where this is necessary. All other stops in Vienna have either platforms on traffic islands or on capes.

2. With regard to the planned line extensions: the ink is not yet dry on the announcement and there are already protests against the new tram lines (with the most abstruse arguments, such as trams endanger children!) Mostly, of course, it's about the fear of losing parking spaces. This actually only secures line 27, which will run through

a previously completely uninhabited area.

Klaus Matzka, Wien

Sunk cost and opportunity in global LRT systems

There is excess capacity in global rail systems, (idle track-time between trains or trams), that could be utilised to generate revenues for system operators and offer positive multiplier effects for communities and regions.

Add a cargo-parcel feeder service for optimal business-to-business replenishment, and business-to-consumer/direct-to-consumer/postal throughput, taking advantage of line-balancing strategies, not available in any other logistics design.

Certain things would be required: (a) Refurbished and/or new cargo wagons, high-speed transfer-balancing points, linking feeder road vehicles, not part of passenger operations. (b) The common denominator: standardised (ISO) feeder RO-RO carts/cages with options to include cold-chain for ease of handling, linking all requested points. Recycling could be added in some cases for 24/7 revenues.

For a feeder concept trial, see what has been taking place in Schwerin, Germany.

Thanks for your publication, it is needed more than many know.

Joe Farley, by e-mail

Do you have something to say?

See your views in print – drop us a line at:

matt@mainspring.co.uk

FRANKFURT: ON PARADE

September's tramway gala in the far reaches of Brandenburg was a splendid effort, in a first-class example of collaboration between a current tramway company and the local enthusiast body. Mike Russell reports.



Frankfurt an der Oder possesses one of the smaller tramways inherited from the former East Germany (DDR) following reunification in 1990. Situated about 80km (50 miles) east of Berlin, the town can trace its history back to the 13th Century but it has never been a big settlement, traditionally straddling both banks of the river Oder. In the post-war era the population rose to around 87 000, but has since declined to roughly 58 000, not helped by the collapse of the principal semi-conductor industry.

The main line railway reached Frankfurt in 1842 but it was over half a century later before the town gained trams. There had been discussion around proposals to introduce horse-drawn tramways but all came to nought, and it was eventually electricity that brought the concept of the street tramway here, the system opening on 23 January 1898.

It was the 125th anniversary of this operation that was celebrated on 16 September 2023; it was quite a spectacle to be mounted by such a relatively small tramway. However, there is a thriving local tramway enthusiasts' club (Historische Strassenbahnen Frankfurt (Oder) e.V.), formed in 1999 to safeguard heritage tramcars which were under a real threat of being scrapped.

The group has the use of Halls 4 and 5 of the original 1898 Bachgasse depot, no longer used by Stadtverkehrsgesellschaft mbH Frankfurt (Oder) (SVF) but comprising covered storage and workshop facilities, and housing an impressive collection of nicely restored heritage cars.

The tramway has endured a chequered history. The town centre was effectively laid waste by the advancing Red Army in the last days of World War Two, causing *inter alia* unspeakable damage to the tramway infrastructure and its rolling stock. The post-war settlement, designed to appease the Soviet Union, ceded lands on the east bank of the Oder to the relocated state of Poland, in the process eliminating the tramway's operating area to Dammvorstadt. With the approval of the Soviet command, however, in May 1945 rails, poles and cars were salvaged from the now Polish part of the city.

As one of the DDR's smaller tramways, proposals were advanced in 1970 for closure of the system. This threat hung over the operation until late 1974, when the policy was reversed by popular demand and the tramway entered a period of renewal.

Although the east bank Oder territory was lost to Frankfurt after 1945, relations between the two communities are very cordial and

there have been discussions about reinstating a cross-river tram route to provide a link with the Polish area now known as Stubice. These have not progressed to date, but who knows whether the future might bring reinstatement of the historic tramway link?

Older cars survive

It was fortunate that the hovering threat to the system had resulted in the retention and continued operation of several elderly cars dating from the inter-war years, some of which were transferred to works duties after their years in passenger service. These provided the basis for what was to become a growing heritage collection.

Another benefit arose some years later, when work was completed on a new depot in Neuberesinchen. This had become necessary to house and maintain the fleet of new articulated cars introduced to replace the older two-axle fleet, and thereby also relieve the undertaking's acute accommodation problem; owing to the capacity inadequacies of Bachgasse depot, this had resulted in trams having to be kept overnight on sections of street tramway track. Part of the original depot was made over for use by the tramway enthusiasts' body for the heritage trams.

Amongst the former small DDR tramways, Frankfurt still retained some cars that pre-dated the post-war Communist era; furthermore, like other ex-DDR tramways, the former system of centralised rolling stock production resulted in gaps being filled by identical acquisitions from other systems.

The parade, assembled chronologically, was mustered on track in Grosse Oderstrasse, normally used as a terminal loop by cars on lines 2 and 3, and diverted to Stadion whilst it was occupied by the convoy. In the lead were the two cars from 1936 built by Triebwagen und Waggonfabrik Wismar AG, 41 and 60, both recovered from works car duties and restored with heritage status in 1994 and 1992 respectively. Both wore the pre-war livery of cream with dark red relief. Car 41 was one of the second batch of three almost identical cars to the first batch (only the roof style and profile differed) initially accorded fleet numbers vacated by older withdrawn cars, in this case 57.

Behind these came LOWA *ETS4* car 38 of 1955, originally in the Stralsund tramway fleet and one of those restored to the later Frankfurt red livery with ivory relief applied to the fleet from the late 1960s onwards. Like others of the type, it was originally built as a double-ended car, but in 1966 converted in Leipzig's Heiterblick works to single-ended

form. It came to Frankfurt in 2002 and received fleet number 38.

This was followed by Gotha *T57* motor car 35, an original member of the Frankfurt fleet and the first of its type in the city. It was in service until 1994, after which it became a works car until restored as a heritage vehicle in 2008, retaining its original double-ended layout.

Not only, but also...

There then followed a two-axle motor and trailer set beautifully turned out in the earlier ivory livery. Car 49 is a single-ended Gotha *T2-62* of 1964, the only such example preserved in Germany; it retains its original condition, with aluminium trim. It was coupled to double-ended *B57* trailer 113 built by Gotha in 1957 and new to Frankfurt, which remained in service until 1994; it is restored to its 1974 condition.

The convoy of passenger cars was completed by three more modern members of the present-day fleet: Tatra *KT4D* cars 212 and 219, the latter in the more recent light green livery, with AdTranz low-floor articulated car 308 in rear, this being one of only eight low-floor cars in the current fleet. Frankfurt originally had 34 Tatra *KT4D* vehicles, but many have since been sold or withdrawn following reduced fleet requirements.

This was not the end of the parade, which had been topped and tailed by other features. The initial cars were preceded by a troupe of marching marionettes, whilst at the end there appeared two works cars. One was two-axle snow plough car 2, a double-ended Gotha *T57* of 1960 converted from passenger car 32. Following was *Schleifi*, a Tatra *T6A2* bogie vehicle adapted for rail grinding acquired in 2011 from Berlin, where it had been 5118.

The parade route was from Grosse Oderstrasse via the centre (Heilbronner Strasse) and railway station to Neuberesinchen depot and this was also used as the afternoon demonstration route for paying passengers. Service continued until 18.00, when all the historic cars returned to Bachgasse depot.

The designated museum fleet contains a further four vehicles not currently in service. These are 29 (Gotha *T57* of 1959 that operated in Frankfurt 1968-95); 119 (LOWA *EB54* trailer of 1954, originally Brandenburg 74); 124 (*Rekowagen BZ70* double-ended trailer of 1974); and 1 (Gotha *G4-61* flat bogie transportation trailer). **TAUT**

› Additional information by courtesy of Rolf-Roland Scholze and Matthias Kühl.



2

1. Wismar-built car 41 dates from 1936 and is one of the two oldest vehicles in the heritage fleet. It is here on Logenstrasse during the morning anniversary parade.

2. This view in Logenstrasse well illustrates much of the closely-formed parade of heritage cars. Nearest the camera is Gotha B57 trailer 113, hauled by T2-62 motor car 49; this set provides a representation of a typical local tramcar formation of the later DDR years.

3. There are small differences in the profile of the roof of the two batches of cars built for Frankfurt an der Oder by Wismar in 1936, of which one of each batch has survived in the heritage fleet. Car 60 is nearest the camera, with 41 in front leading the parade as they pass along Logenstrasse.

4. To a musical accompaniment provided by young local artists the tramway parade moves off from Grosse Oderstrasse into Logenstrasse. The two tramcars leading the rolling stock parade are cars 41 and 60 dating from 1936.



3



4

5. The city centre turning loop includes a section of street running in Bachgasse, where former industrial buildings survive. The historic tramway depot is on the opposite side of this thoroughfare, which LÖWA car 38 is traversing as part of the special public journeys operated after the parade had finished.



5



6

6. A good parade of rolling stock should always include representatives of the works car fleet, and Frankfurt did this aspect of operations justice by including snow plough 2, nearest the camera, with *Schleifi*, the ex-Berlin rail-grinder, following behind.



7



8

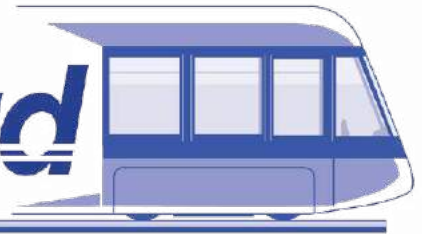
7. The twin set of two-axle cars 49+113, the former festooned with festive bunting for the anniversary, turn from Logenstrasse into Gartenstrasse on the city centre turning loop whilst providing part of the public service to and from the open day at Neuberresinchen depot during the afternoon.

8. Double-ended Gotha T57 car 35 leaves Dresdenerplatz to enter Bahnhofstrasse and pass beneath the main line railway tracks whilst operating one of the afternoon special public service journeys between the depot and city centre.

All photography by Mike Russell on 16 September 2023.



TramForward



NEWS FROM THE LIGHT RAIL TRANSIT ASSOCIATION

Proposals for hydrogen tramcar in Aberdeen

A continuation of our series looking at how light rail can benefit towns and cities in the United Kingdom.

TramForward led by Jim Harkins has had several discussions with Aberdeen Council about developing a hydrogen hub for the Aberdeen Harbour South Area.

This follows a report by HR Wallingford for the Harbour Board on the development of the harbour to permit larger cruise ships to visit. The report showed that improved road and rail networks would be needed to facilitate the expansion of the harbour. The proposed Aberdeen Harbour City Connector would provide direct access to the city centre (Union Square), and a link to the bus and railway station with a frequent and flexible service to the harbour for cruise ships.

Why a hydrogen tram? Supplies are local, allowing for on-site hydrogen generation.

On-board fuel cell generators charge the batteries while the street car is in passenger service, so the energy required for a full 20-hour service day would be carried on each vehicle. Modelled on the TIG/m trams in Doha, Qatar, the proposal for a Very Light Rail system will see a dramatic reduction in construction costs, faster construction and less disruption compared with conventional light rail systems.

In addition, TramForward has submitted proposals for the A92 Bridge of Dee to Don and the A944-A9119 route repurposing existing carriageways for light rail.

Further information on these proposals can be found at <https://applr.org.co.uk/Aberdeen-South-Harbour>

Phillip Heywood

It is with sadness that we have to announce the sudden death of Phil Heywood, former Chairman of the Manchester Transport Museum Society (Heaton Park) on 26 November 2023.

Phil was born Phillip Benton Heywood in April 1950 and was the younger brother of Joyce. Following a degree at Salford University, Phil joined the Civil Service as a Quantity Surveyor and Project Manager.

Phil was a passionate transport enthusiast and would often be seen at the Severn Valley and Keighley & Worth Valley Railways. He also had a keen interest in road transport and was co-owner of a Leyland PD2 bus, had shares in a rare AC Car, and was a leading member of the Dolomite Club.

However, it was his passion for tramways and especially Heaton Park that he will best be remembered for. He was one of the leaders in the development of the new depot at the Lakeside end of the tramway, working tirelessly to secure funding for the project. Phil became Society Chairman in 2016, securing the preservation of T68 1007 along with many items from the original 1992 Metrolink. Phil stood down as Chairman in 2022 but continued to represent the society and take part in the society's activities.

Phil's other passion was his involvement in the Manchester Model Railway Group, which he enjoyed operating, but also planning the layout for different events. Indeed he was working on the latest display for the Warley Model Railway Exhibition when he fell ill and was admitted to the Salford Royal Hospital, where he passed away.

His funeral was held at Agecroft Crematorium in Salford on 11 December, where the chapel was packed with his family, friends and colleagues. **KW**



➤ **RIGHT:** Hydrogen-powered trams such as those built by TIG/m that run on the Downtown Oranjestad Streetcar system could be used on the streets of Aberdeen.

TIG/m

MEETINGS & EVENTS

Compiled by the LRTA. For a full list of the year's events and meeting places, including online meetings, visit www.lrta.org

FEBRUARY

➤ **Tuesday 6.** Southampton, 19.30, Stephen Bigley: Railways of the West Country. Eastleigh Railway Institute, £3. (LRTA/SEG)

➤ **Monday 12.** Leeds, 19.30, Mel Reuben: Buses from the past.

The Engine House, Middleton Railway, Moor Road, Leeds LS10 2JG Contact leeds@lrta.org, £1 includes light refreshments. (LRTA/LTHS)

➤ **Saturday 17.** 16.00. David Edwards: Alexandria & Bits of Europe. West Monkton Village Hall, TA2 8NE. westofengland@tlrs.info. £2. (TLRS)

➤ **Monday 19.** Merseyside, 19.30 for 19.45. Rob Jones: Chester tramway system. Sefton Park Community Association, 3 Croxteth Drive, Liverpool L17 3AG Contact: merseyside@tlrs.info (TLRS)

➤ **Wednesday 21.** Zoom meeting 19.30 Dave Carson: Lion City

Railways: Singapore MRT & LRT. Contact: alo@tlrs.info (TLRS)

➤ **Saturday 24.** Nottingham, 14.00. Modelling session: Bring along what is on your bench. Beeston Scout Hut, Middle Street, Beeston, NG9 1GA Contact: alo@tlrs.info (TLRS)

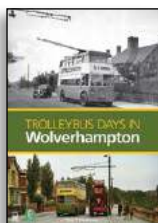
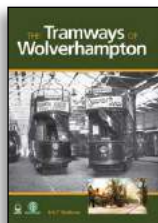
For more information on the Association and its activities visit www.lrta.org

Order online from www.lrta.info/shop - or by post from:

LRTA Publications, 38 Wolseley Road, SALE, M33 7AU

(Please provide telephone contact details and quote LRTA membership number if applicable)

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Trolleybus Days in Wolverhampton / The Tramways of Wolverhampton

NEW YEAR
OFFER

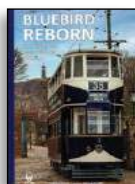
These two books – published in 2017 – comprehensively describe the electric traction era in this historic West Midlands city, from the predecessor horse trams in 1878 through the electric trams from 1900-28 after which trolleybuses reigned supreme until 1967. The unique and troublesome stud contact system was completely changed over to standard overhead wire traction by 1921, but the trolleybus began to replace its predecessor just two years later.

➤ Both books A4 softback; 112 (tram) 240 (trolleybus) pages, fully illustrated in black & white and colour.

Both books together – limited to 12 copies: **£18.50** (UK); **£27.50** (outside UK); **£40.00** (Airmail Z1); **£45.00** (Airmail Z2/3);

Trolleybus Days ONLY - **£15.00** (UK); **£23.50** (outside UK); **£35.00** (Airmail Z1); **£40.00** (Airmail Z2/3)

Bluebird Reborn



This book celebrates the return to original condition of the 1931 experimental London County Council tram, telling its story from outline drawings through operation in London and Leeds, to display in the first British Transport Museum and a new life at Crich Tramway Village.

➤ A4 hardback; 224 pages, 330 colour and black & white pictures, four maps.

£38.50 (UK addresses); **£49.50** (outside UK); **£58.50** (Airmail Z1);

£63.50 (Airmail Z 2/3); LRTA Members: **£3.50 discount**

Japan Tram Atlas



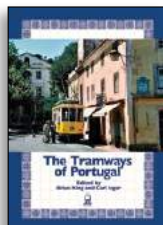
A comprehensive review of the tramways and trolleybuses of Japan with superb track maps for every system. Details of the car types operated and the routes on which they run are covered. English and German text.

➤ A4 softback; 272 pages, 423 colour and black & white pictures, 48 track maps.

£36.50 (UK addresses); **£46.50** (outside UK); **£56.50** (Airmail Z1);

£61.50 (Airmail Z2/3); LRTA Members: **£3.25 discount**

The Tramways of Portugal



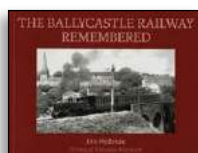
This new fifth edition of the popular LRTA handbook has been expanded to include the new installations in Lisboa and Porto. It also provides wider coverage of the trolleybuses, providing a comprehensive overview of electric street traction in Portugal.

➤ A4 softback, 328 pages, 400+ black & white and colour pictures and 57 maps.

£48.50 (UK); **£55.00** (outside UK); **£59.50** (Airmail Z1);

£65.00 (Airmail Z2/3); LRTA Members: **£4.50 discount**

The Ballycastle Railway Remembered



A superb collection of images of this fabled narrow-gauge railway in what became Northern Ireland. The turbulent history of the line from 1880 to 1950 is briefly set out and the stations, depots and rolling stock are comprehensively illustrated.

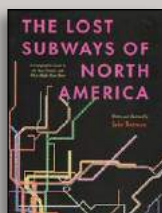
➤ 240x180mm softback, landscape format; 64 pages, 65 black & white and one colour pictures, one map.

£21.00 (UK); **£23.50** (outside UK); **£25.50** (Airmail Z1);

£27.00 (Airmail Z2/3); LRTA Members: **£1.80 discount**

For further details of all these books go to our website.

Order direct from the website shown (not from the LRTA)



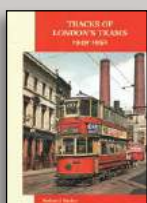
The Lost Subways of North America

A cartographic guide to the past, present and what might have been. This fascinating book chronicles the development of streetcar, subway and urban rail systems in 23 US and Canadian cities, seeking to explain the demise of vast networks of fixed track public transport.

➤ 285x225mm hardback; 272 pages, 107 full-colour maps.

USD 35.00 – www.press.uchicago.edu/ucp/books
www.amazon.co.uk

Tracks of London's Trams 1949-1952



An interesting collection of anecdotes highlighting the painful final years of the capital's first-generation tram system, including the impact on tramway staff and passengers of the demise of this much-loved means of travel. The atmospheric views of trams in their natural South London habitat show just how much we have lost.

➤ A4 hardback; 96 pages, 84 black & white and 25 colour pictures plus track layout drawings.

£25.00 – www.capitaltransport.co.uk

European Light Rail Congress



TWO days of **interactive debates**... EIGHT hours of **dedicated networking**... ONE place to be

Hotel Melia Lebreros – Seville, Spain

13-14 March 2024

The **European Light Rail Congress** brings together key decision makers and leading professionals from across Europe for two days of debate covering the role of technology in the development of sustainable urban travel.

With presentations and exhibitions from some of the industry's most innovative suppliers and service providers, this congress also includes a technical visit and over eight hours of networking sessions.

For 2024 we are taking the congress to the beautiful Spanish city of Seville, home of the Metro de Sevilla system. Both metro and trams run throughout the city providing modern and efficient public transport, with safety and the environment being key factors which contribute to improving the quality of life of the citizens of Seville and the surrounding areas.

The event will be held at the Hotel Melia Lebreros, which provides a superb conference centre that offers everything under one roof for everyone to enjoy. We will be working with our partners once again to offer a superb behind-the-scenes depot visit for delegates; and have also arranged an evening reception with some fantastic food and drinks to allow for maximum networking opportunities.



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