

GLOBAL TRAMWAY & LIGHT RAIL PROSPECTS

2021 and beyond



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mainspring Knowledge

INTRODUCTION

In the first two decades of the 21st Century, more than 160 new tramway and light rail systems around the world have opened to passengers. This pace of openings has been increasing, with an average of 11 new systems per year over the past five years, as more and more cities recognise the benefits.¹

Continued growth in automobile usage is not an efficient use of urban space in our already crowded towns and cities. Urban gridlock conditions cost the UK an estimated GBP6.9bn in 2019, similar figures for German cities indicate EUR2.8bn, while in the US citizens lost 99 hours per year due to road congestion, at a consequent impact on the economy of nearly USD88bn per annum.²

The further increasing importance of climate considerations in our everyday thinking show that ‘business as usual’ solutions – with a reliance on private travel modes – are unsustainable in both socio-economic and environmental terms.

For the purposes of this latest paper from Mainspring Knowledge, the term light rail (LRT) is used to describe any fixed-track transport system that runs within an urban or interurban environment with the exception of full-segregated heavy metros that use technology more akin to main line rail networks.

This definition therefore includes tramway, streetcar, Very/Ultra Light Rail (VLR/ULR) and tram-train applications. The vehicles can be either single-car units, or form coupled-unit trains, but all feature the traditional steel wheel-on-steel rail interface and in almost all cases electricity as the primary form of motive power.

Three key benefits are realised with tramway or light installation:

- Improved accessibility, connectivity and social mobility
- Catalysing regeneration and economic transformation
- Driving modal shift; a genuine green alternative to the automobile.

Trams and LRVs are significantly more energy efficient than rubber-tired modes, with lower overall associated running costs due to the lower resistance between steel wheel and steel rail. Operational costs are also lower per passenger numbers carried.

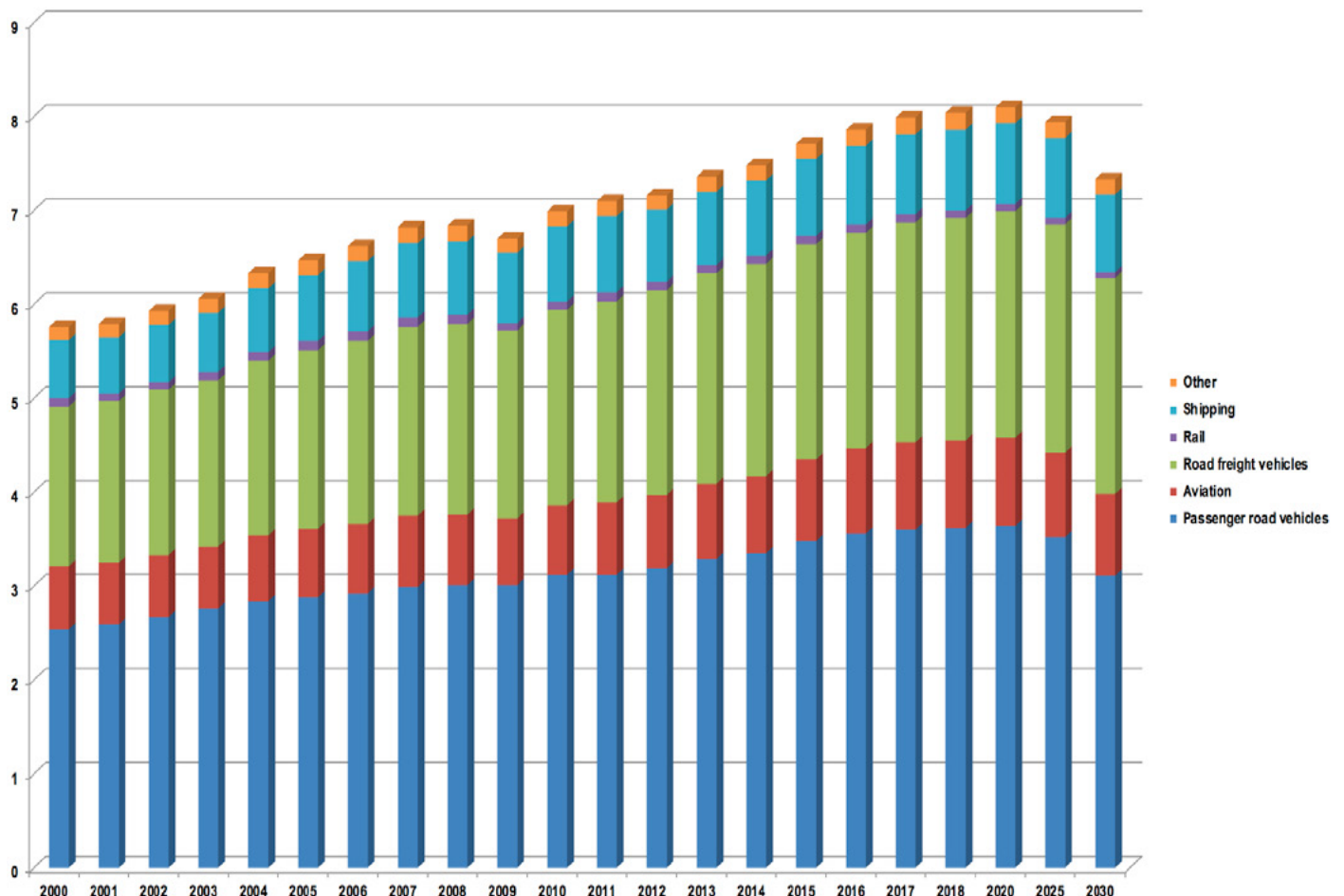
In environmental terms, trams and light rail vehicles (LRVs) are more environmentally-friendly at point of use, with far lower emissions per passenger-km than traditional combustion-engined urban buses (around a third) or automobiles (around a fifth).³

In 2018, transport accounted for just over a fifth of global CO₂ emissions, with road vehicles accounting for three-quarters of this figure (including cars, buses, motorcycles, taxis, vans and lorries) – around 15% of the global total. By contrast, rail travel, in all its forms, emitted only around only 1% of transport emissions.⁴

As we seek to reduce city, regional and national carbon footprints, a shift to more efficient mass transport needs to be an imperative, and is one of the easiest routes to large-scale change.

As well as reductions in CO₂, mounting evidence of the harm caused by NO_x and microparticulate matter can also be addressed through the adoption of rail transport. A landmark UK ruling in December 2020 found that high levels of NO₂ and particulate matter in the environment were a contributory factor to the death of a nine-year-old girl in London. The ramifications of this legal ruling could be significant. Other studies have shown that high levels of airborne pollutants could be attributable causes to over 30,000 deaths each year in the UK and over seven million people around the world.^{5, 6}

Congestion charging and pedestrian zones may remove the highest-emitting vehicles from urban centres, but there needs to be a suitable alternative for short to medium-length journeys.



Source: Transport sector CO₂ emissions by mode in the Sustainable Development Scenario, 2000-2030: IEA, Paris
www.iea.org/data-and-statistics/charts/transport-sector-co2-emissions-by-mode-in-the-sustainable-development-scenario-2000-2030

An exemplar of modal switch is the city tramway in Zaragoza, Spain, which has published quantifiable data around improvements to air quality and the reduction in private vehicle usage in the city. With around 8% less traffic on the city's roads since the tramway's inception, Zaragoza now fulfils not only the strict regulations around air quality demanded by national legislation, but also exceeds even the highest requirements of the World Health Organisation (WHO). Just three years after the opening of the first line, the city's tramway welcomed its 100 millionth passenger, with an average of 100,000 passengers per working day – and all in a city of just 700,000 people.⁷

In socio-economic and 'city-building' terms, interesting opportunities surround the enlightened use of light rail as a catalyst for the creation of 'Smart City' infrastructure. For example, the KC Streetcar in Kansas City is a fundamental component of this US city's wider public policy ambitions; new light rail infrastructure (implemented in 2016) was the catalyst in the formation of a digital backbone that incorporates high-speed public Wi-Fi, integrated smart LED street lighting and sensors on key city infrastructure components to monitor weather conditions.⁸

Investment in urban rail gives an additional sense of permanence not seen with other modes and ever since the first days of the railways, developers have profited from the increased land values, footfall and prosperity that comes with light and urban rail development. These benefits can be quantified by two key measures: direct and indirect job creation, and inward investment and regeneration.

For example, The UK's Nottingham Express Transit Phase Two generated over 1600 direct jobs at its peak construction in 2016, and the expanded system has created further ongoing career

opportunities.⁹ Internationally, tramway and light rail development plays a similarly vital role in the shaping of cities, with the Swedish capital, Stockholm, investing around EUR4.5bn in the period 2010-21 to support regional development as well as national environmental aims. This includes underpinning residential developments of almost 30,000 new homes along new light rail and metro routes, enabling connections to over 80,000 workplaces and creating a new fast link to Bromma Airport, the closest airport to the city centre.¹⁰

Across the Atlantic, the Texan city of Dallas famously quotes the transformative effects of its 20-year light rail programme as having delivered USD1.72 in regional economic activity for every USD1 spent (USD8.8bn from a USD5.1bn investment). The regional transit agency projects a total of USD10.8bn in existing, under construction and planned developments around DART's (Dallas Area Rapid Transit) 64 light rail stations.¹¹

In this study, we will provide a continent-by-continent overview of the new tramways and light rail systems planned to open in 2021 (13 in total), comparing these figures with the new lines that have opened in the last five years as a benchmark (see page 14).

We are focusing on cities where the installation of tram or LRT lines is a new development, where new types are being employed, and standalone lines in areas that already feature rail-based mass transit.

There are many ongoing expansion programmes where new infrastructure is being added to existing systems – Mainspring Knowledge holds key data on all of the world's tramway, light and urban rail projects, available on request.



◀ Light rail, US-style: The Dallas Area Rapid Transit network features mainly-segregated routes and opened in 1996. It now covers four lines. Michael Barera / CC BY-SA 4.0



▲ The archetype of modern European low-floor design, Strasbourg's tramway opened in 1994 and has seen constant expansion. Florian Fèvre / CC BY-SA 4.0

▼ The UK's 'Urban VLR' concept aims to dramatically reduce both installation and operational costs for city rail systems. Courtesy of Transport Design International



▶ Modern tram-train systems such as those in the Paris region allow for high-quality links between neighbouring communities, sharing routes with heavy rail. Remontees / CC BY-SA 4.0



AFRICA

OVERVIEW

Tramway and light rail development across the continent is sporadic, with wide variations in national policy and ambitions between the north and south, east and west.

Notable developments have taken place in northern nations. From the ten new systems opened across the continent in the last decade, eight have been in Morocco and Algeria. Reflecting its sphere of influence in the region, these systems have largely been developed using finance, design and equipment suppliers from France, partnered with domestic contractors.

The two outliers are the light rail lines in Addis Ababa (primarily Chinese financed and equipped) and the modern LRT system on the island of Mauritius. The first phase of the latter (Port Louis to Rose Hill) opened in 2019, with a single line primarily reusing former rail alignments. This is due for completion with a southern second phase to Curepipe in 2021.



OPENING IN 2021 - ALGERIA

The only new system in Africa predicted to open this year is in the Algerian port city of the Mostaganem (population 250,000), situated on the Mediterranean coast around 80km east of Oran.

Algeria began its modern tramway development programme over 35 years ago. Faced with growing traffic and congestion in its main cities, principally in the Mediterranean coastal belt, the nation's Transport Ministry embarked upon a number of concurrent tramway projects under the remit of state-owned Entreprise Metro d'Alger (EMA), established in 1984.

For future operations and maintenance, a special purpose vehicle, Société d'Exploitation des Tramways (SETRAM), was set up by EMA, Etablissement Public de Transport Urbain et Suburbain d'Alger (ETUSA), and Paris-based transport operator RATP Dev in May 2012. EMA and ETUSA together hold a 51% stake, while RATP Dev holds the remaining 49%.

To serve both the Algerian and wider Middle East and North African (MENA) market for tramway rolling stock, CITAL was created in 2011 as a joint venture between domestic rail company Ferroviario (41%), EMA (10%), Alstom Transport France (43%) and Alstom Algérie (6%). CITAL has a 50,000m² facility in the port city of Annaba, including a dedicated 800m test track. This site has created around 400 jobs, importing LRT expertise from Alstom's European sites. CITAL has since been appointed as maintenance contractor on all the new Algerian tramways, but the promise of a steady pipeline of orders has dissipated.

Although there were once proposals to install tramways in all major towns and cities, only six have been realised up to 2020. Prospects beyond this have receded due to a deteriorating national economy, largely resulting from a significant drop in vital oil and gas revenues; planned extensions of the existing systems are also delayed.

EMA officials still expect tramway plans to progress in the cities of Annaba (a 21.8km network) and Batna (a 15km line) to go ahead as soon as budgets are available. These were both postponed due to a major downturn in the Algerian economy in 2015, but it is hoped that works can resume in the next few years.

Although construction on 14.5km of tramlines in Mostaganem has been underway since August 2013, substantial delays can be attributed to bankruptcy of the original contractor, flooding and subsidence. After a lengthy suspension, work resumed in 2018 using an Algerian contractor for infrastructure works, assisted by project managers and technical experts from Turkey.

A fleet of 25 Alstom Citadis 402 43.9m bi-directional trams has been delivered from the CITAL joint venture in Annaba. With steep main line gradients, all three bogies are powered and cars also feature enhanced air-conditioning for comfort in the high summer temperatures. Trial running began in December 2020 and inauguration is now confidently predicted for spring 2021. Forecasts are for 3000 passengers per hour per direction.



The main line (T1) runs from the southern terminus at Lycée Oukraf Mohammed to Université Kharouba in the north; 5.5km from there T1 meets the much shorter T2 to the Nouvelle Gare Routière. Here, a small depot has been constructed to house the six trams used on this route.

Line T2 will serve four stops, including the termini. One intermediate stop and the eastern terminus will have island platforms. Although the two lines are connected by a single line junction with a pair of adjacent crossovers, through running is not currently envisaged. T2, with its allocation of just four trams, will be operated as a shuttle with a single-line stub terminus.

Major engineering interventions on the EUR250m project include a new viaduct and three underpasses solely for tram use. A total of 24 stops are being built.

ASIA

OVERVIEW

Asia – including the Middle East – has seen perhaps the most remarkable renaissance over the past decade, opening no less than 33 new tramways and LRT systems in the past decade.

More than half of these (21) have been concentrated in East Asia, driven by rapid urbanisation and primarily as complementary investments to major metro installations. This is seen most prominently in China, where dramatic socio-economic shifts and the adoption of 'Five-Year Plans' give a clarity of focus; technological innovation is highly prized, with domestic suppliers providing advanced solutions as a testbed for future export ambitions.

Similarly in the Middle East, high levels of investment have been seen on rail systems in the UAE and Qatar, featuring innovative traction power supplies, digital systems and cutting-edge automation. Transitioning to renewable energy sources, these economies are promoting sustainable travel solutions delivered through advanced technologies.

Over the same period, five new tramways have opened in the Asian provinces of Turkey, although these are very much more 'traditional' in nature. Turkish manufacturers and supply chain partners are also developing rapidly, delivering high-quality products to the domestic market with wider ambitions (and some successes) in Europe.



OPENING IN 2021 - CHINA

New tramway openings in China are often announced at the last minute and with little of the official fanfare associated with European or North American projects. That said, three new projects we have been tracking can be reasonably be expected to open to passengers this year.

Following the recent model, they all offer high levels of technological sophistication from domestic contractors evolving European designs acquired via technology transfer and licensing agreements signed over the last decade.

The first new system has driven much international interest due to its highly-specialised rolling stock, designed for operation at both high altitude and extreme temperatures.

Delingha is capital of the Haixi Mongol and Tibetan Autonomous Prefecture, located 2982m above sea level. Heavy rail services on the Qinghai to Tibet railway use trains equipped with oxygen supply.

Trail operation on a 14.4km two-line tramway began in May 2020, using 25 two-section low-floor trams built by CRRC Qingdao Sifang built under a licence agreement signed with Škoda Transportation in 2013. The vehicles feature energy storage using supercapacitors and lithium-titanate batteries specially adapted for high-altitude power delivery. Charging is undertaken via rigid catenary at stops and in the depot. An April 2021 opening is likely.

The second system is in Wenshan (Yunnan Province), where in late 2020 CRRC Zhuzhou delivered the first of 15 'Xiaohong' 100% low-floor trams for a new 13.95km tramway that is also planned to open in April. The four-section cars have a top speed of 70km/h and capacity for 364 passengers, 72 seated. Traction power is provided by a hybrid system of onboard supercapacitors and lithium-titanate batteries which it is claimed can be fully charged in 30 seconds via stop-mounted charging infrastructure.

Ground-breaking on the CNY2.3bn (EUR297m) project (known as Line 4) took place in January 2018, with works allocated under a PPP agreement that also covers operations; staff training has been undertaken on the established tramway in Suzhou.

The first phase features ten stops, a depot and control centre; the main corridor runs for 11.7km from the Tourist Service Centre to Puzhehei railway station with eight stops. The mainly-segregated line features five road crossings. There is an additional 2.25km two-stop branch to Jiaolian Square.

Main construction works were almost complete at time of writing, with the first energisation trials taking place in January.

The third new tramway is in Jiaxing, a city of 4.65 million people in Zhejiang Province. Work began on a CNY2.85bn (EUR360m)



two-line tramway 15.6km long, including interchange with the high-speed rail station at Jiaxing Nan in December 2019. Operations and maintenance are to be undertaken by a joint venture of Keolis and Shanghai Shentong Metro Group, with an opening date set for 1 July.

A fleet of 20 supercapacitor-equipped low-floor trams is being supplied by CRRC; 50,000 passengers/day are expected. A third 20km line, adding 55 stops, is planned for 2023.

OPENING IN 2021 - NORTH KOREA

Originally planned to open in April 2020, completion of a 7km tramway loop serving the expanding port city of Wonsan and its new beach resort (population approximately 330,000) has been delayed by the effect of sanctions and coronavirus.

Designed in conjunction with expansion of the city's existing trolleybus network (state media reports three new routes and re-equipment are underway), the loop will serve the expanding beach resort and commercial and entertainment complex, as well as a new personal compound for North Korea's leader Kim Jong-Un.

A dual-use military and civilian airport (Kalma) was built adjacent to the resort, opening in 2015.

While reliable information and project updates can be difficult to verify, it is reported that the new narrow-gauge line will be laid as a single-track loop served by low-floor bogie trams built to a new design by the Kim Chong-t'ae Electric Locomotive Works. Main construction was reported to be complete in November 2020.

Trams will operate clockwise around the loop, and it is understood that operations and maintenance will be the responsibility of the military.



OPENING IN 2021 - QATAR

A key pillar of the Qatar National Vision 2030 is the delivery of sustainable infrastructure that also respects the nation's culture and heritage. With one of the world's highest GDP per capita, the development of vast new cities and a stated aim to reduce reliance on fossil fuels in favour of renewable energy, the provision of high-quality, environmentally-friendly transport is of paramount national importance.

A good prospect for passenger operation in early 2021 is the first phase of the Lusail tramway, designed to serve a new 38km² waterside development in the northern suburbs of the capital Doha which will also host a number of 2022 FIFA World Cup venues.

The tramway forms part of a comprehensive mass transit policy for the capital that also includes an advanced driverless metro. A 20-year concession to operate and maintain this and the 28km four-line standard-gauge tramway (7km in subway) has been awarded to RKH Qitarat, a joint venture of Hamad Group (51%) and French transport companies Keolis/RATP Dev (49%).

Alstom is providing 28 five-section 100% low-floor Citadis XO5 trams (with an option for a further 32). In line with the National Vision's importance placed upon retaining a link to Qatar's unique cultural heritage, the styling of the new trams is based upon traditional dhow pearl fishing boats. Alstom's EUR750m project allocation is part of a wider EUR2bn Franco-Qatari joint venture and includes signalling and platform screen doors as well as its APS surface contact current collection system; this is used throughout, except in the subway and depot, where rigid overhead is installed.

Technical trials started in November 2020 and a phased opening is proposed: the first section covers 13 stops, with a further 12 in the second. The tramway also connects with the new automated metro Red Line at Lusail and Legtaifiya stations.



EUROPE

OVERVIEW

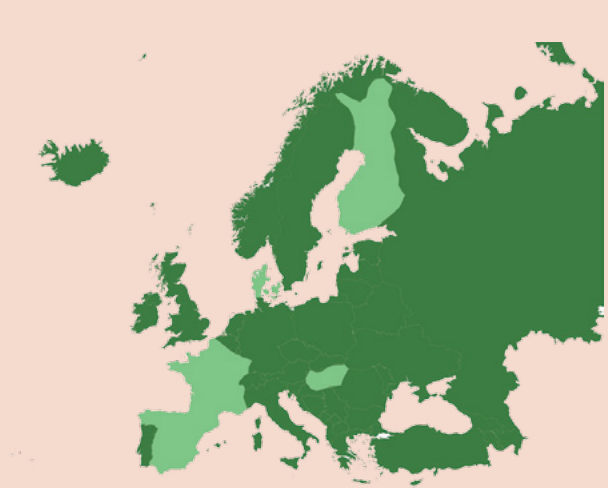
With by far the largest proliferation of both tramway infrastructure and vehicles, of the 44 European nations, only eight have never featured a tramway or light rail service – and most of these are microstates. Currently 31 capitals feature a tramway, many of which date back to the original installations from the 19th Century when trams were the primary mode of city transport.

With a total annual ridership of 10.42bn in 2018, Europe's tramway and light rail systems carried as many passengers as metros and regional/commuter rail over the same period, and more than ten times that of air travel on the continent.¹²

Over the past decade, 30 new cities have reintroduced light rail service under a variety of guises, from traditional street-running systems to fully-segregated light rail and tram-train lines. Another five could join them in 2021, although the design, construction and operational concepts vary widely.

The continent can also claim the first tramway opening of 2021, with the introduction of the initial 8.8km of the new T5 line that follows the European coastline of the world-famous Gold Horn inlet of the Bosphorus. Istanbul's fifth standalone tramway was inaugurated on 1 January; coronavirus restrictions saw the first passengers carried three days later.

This EUR153m project is noteworthy for being the first time a licensed version of the APS surface current collection system has been fitted to vehicles other than that of Alstom. Thirty Durmazlar-built five-section Panorama trams are employed, serving 12 stops daily between 06.00 and 20.40. A further 1.4km two-stop extension is planned to open in 2022.



OPENING IN 2021 - DENMARK

Denmark has an important place in tramway history. Its capital, Copenhagen, opened one of Europe's earliest horse-drawn passenger services in 1863, passing through phases of steam power and battery operation before overhead electrification just before the turn of the 20th Century.

The mode never achieved widespread popularity across the nation however, with city tramway operation only developed in Aarhus, Odense and Copenhagen (as well as an unusual 750mm-gauge service on the island of Rømø).

Mirroring the familiar tale worldwide, the increased costs of maintenance fought against the competition from other modes and the growth of the private automobile; Denmark's final passenger tram ran in Copenhagen on 23 April 1972, with its rolling stock sold to Alexandria in Egypt.

However, the 21st Century has seen environmental imperatives and a retreat from automobile-focused development led to the adoption of a number of new schemes – the first opening in Aarhus in December 2017. This pioneering system includes both street-running and tram-train operation and a mixed fleet over a major 110 route-km network.

Tramways are seen as an ideal transport solution for Danish cities due to their moderate size. Copenhagen is the exception, and here the Ring 3 LRT line will encourage development and inward investment in the municipalities investing in the scheme, forming a key part of the overall regional development plan.

This year's opening is in the southern city of Odense, Denmark's third-largest city and an important commercial hub, with a population of over 200,000 that is projected to grow by a further 10% by 2040. The city's first-generation tramway closed in June 1952.

In 2014 approval was given for a 14.5km tramline, with a budget of DKK2.98bn (EUR400m). The state is contributing DKK1.1bn (EUR148m), the Region of Southern Denmark DKK100m (EUR13.4m), with the city financing associated urban improvements worth DKK118m (EUR15.9m).

The 26-stop line runs from Tarup in the north-west, via Kongensgade and Banegård (the railway station) in the city centre before turning south to the University (Campus Odense), the hospital and a terminus at Hjallesø station. Work began in August 2017. Green track will cover approximately 10km of the route and



it has been stipulated that two trees will be planted for every one removed during construction.

Stadler Pankow (now Stadler Deutschland) has delivered 16 29.2m Variobahn low-floor trams, the same type used in Aarhus. The first arrived in February 2020, with passengers able to board in autumn 2021.

Operations will be provided by Keolis, also contracted to run the city's buses, under a DKK1.2bn (EUR161m) 15-year deal. Keolis also handles operations in Aarhus. End-to-end journey times will be 42 minutes and 35,500 passengers/day are expected.

Plans are being made for a second phase (a north-east branch), but finance is yet to be allocated.

OPENING IN 2021 - FINLAND

Tramway history in Finland follows a similar path to that of Denmark, with only Helsinki retaining its metre-gauge system when the rest of the nation's cities closed their networks. The last tramway outside the capital, in Turku, closed in 1972.

Adopting policies of reducing its reliance on fossil fuels, at the same time supporting sustainable growth and improving air quality, the first new tramway of the modern era to open will be in the city of Tampere, 160km north of Helsinki.

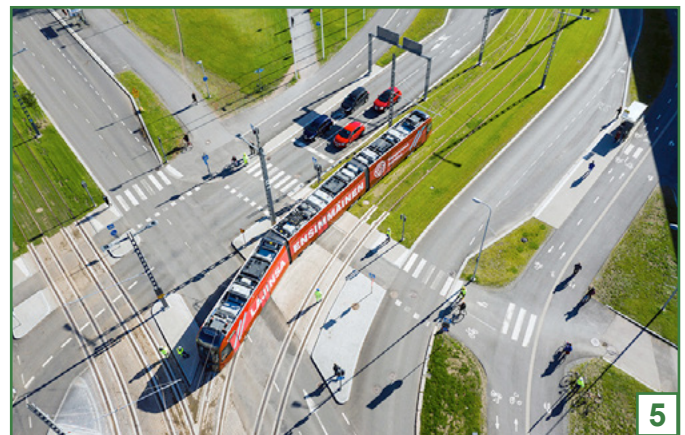
Tampere is the most populous inland city in the Nordics, with 238,140 in the city and almost half a million in the wider urban area. A major economic and cultural hub, it lies between two lakes with hydro-electricity generated from the rapids linking them.

The city's first ambitions for a tramway date from 1907, but these were never realised and subsequent proposals were disrupted by the turbulent war years, and later shelved in favour of trolleybuses in 1948. These lines were converted to motor bus operation in the 1970s, with the last running in 1976. A tram-train project considered in the early 21st Century came to nothing, and over the next decade tramway plans were revived at various times with a decision to proceed gaining overwhelming approval in 2016.

Škoda Transtech was awarded the EUR104m rolling stock contract for 19 standard-gauge 37.3m ForCity Smart Artic double-ended cars, built at Otanmäki (around 430km to the north-west of Tampere); platforms are being constructed to 47m lengths to allow for additional sections to be added as required. The three-section low-floor trams have capacity for up to 264 passengers (104 seated) with city residents heavily involved in the design and choice of livery via extensive public consultation. The contract for operations was placed with VR (Finnish Railways) in 2019.

The first phase covers an 11.5km north-south route from Pyyrikintori to Hervantjärvi via the central railway station, including 19 stops. A further 4.74km eastward branch with four stops will serve the large Tampere University Hospital. The depot lies 990m off the main running line at Hervanta. Main construction on phase one began in 2017 with an estimated project cost of EUR238.8m.

Test running began in the summer of 2020. The tramway's commercial speed will be 19-22km/h, with services running to 7.5-minute headways most of the day from 04.00.



Following the opening on 9 August, work will continue on a 7km second line – a north-western branch from the 2021 terminus at Pyyrikintori to Lentäväniemi via Lielahiti, sharing tracks with line 1 in the city centre. Approved in October 2020, this is due for completion in 2023-24. Eventual aspirations are for a 43km network, putting 85% of the population within walking distance of a stop.

OPENING IN 2021 - FRANCE

Often held up as a model of the European light rail renaissance, it can be argued that no other country has done more to progress the development of the modern tramway as a solution to urban congestion and sustainable development than France.

By the late 1950s, most cities had replaced trams with motor bus or trolleybus systems, leaving just three small systems in Lille, Marseille and Saint-Étienne that all had particular characteristics related to their routing or geography that helped ensure their survival. Only Paris built an operational metro (opening in 1900), and elsewhere passenger numbers were in steep decline as bus systems received little investment and their routes became increasingly clogged by the growth of private car traffic.

The 1973 oil crisis, allied to increasing pollution and congestion on city highways, made public opinion favourable to a new approach. In 1971 the versement transports (VT) was introduced in the capital, a 2.6% payroll tax on companies with more than 11 employees, hypothecated to public transport. In 1973, this was extended to all urban regions with a population over 300,000 (100,000 from 1974), with the level set locally (generally 1.75% if significant infrastructure is planned).



The VT model (now VM – versement mobilité) has subsequently contributed billions of Francs (later Euros) towards public transport investment, including new tramways, and is increasingly used also for revenue support.



EUROPE (CONTINUED)

Since 1985, 25 new tramways have opened – an impressive statement of modernity and a commitment to sustainability for a country with a population in 2020 of just over 65m.

With steady expansion, Paris now features 105km of tramlines, mostly standalone routes without connections. Even where a link exists (T1/T2), incompatible rolling stock (different widths and lengths) means there are no through passenger services.

This year will see the addition of another standalone line, T9, running 10.3km from Métro station Porte de Choisy to Orly Ville (Place Gaston Viens). The line is designed to relieve pressure on the second-busiest bus route of state-owned transport operator RATP (183, Porte de Choisy to Aéroport d'Orly, terminal Sud) by giving non-airport riders a choice for local journeys from 19 new stops in the fast-developing suburbs. T9 will also offer a connection with tramline T3a at Porte de Choisy, and the RER commuter rail line C at Choisy-le-Roi.

When the Grand Paris Express orbital metro line 15 opens later in the decade, it will cross T9 at Vitry Centre. A future link may run from the outer terminus to a connection with T7.

Competitive tendering has seen the 66-month operations contract for T9 (and seven local bus routes) placed with Keolis. Excepting tram-train lines T4 and T11, RATP has operated all the tramlines in the Île-de-France region since the 1992 opening of the first T1 line.



In November 2016, regional transport authority Île-de-France Mobilités awarded Alstom a EUR70m contract for 22 Citadis XO5 trams for T9, with deliveries starting in November 2019. Each seven-section 45m vehicle can carry up to 314 passengers.

The planned December 2020 opening of T9 was delayed by the pandemic, with test running beginning on 30 November. Passenger service is now expected to begin in April 2021.

OPENING IN 2021 - HUNGARY

Almost half of Hungary's city tramways closed during the 1960s and 1970s due to downturns in the nation's economy and the life-expiry of vehicles and systems deemed more economic to replace with motor bus services.

Four systems survived, and in 2021 one of these will be expanded to include the country's first tram-train service in a move designed to reduce congestion and improve the competitiveness of public transport between Szeged (Hungary's fourth-largest city, with a population of around 165,000) and neighbouring Hódmezővásárhely (26km to the north-east, population 47,500).

Szeged's 17km four-line tramway opened in December 1884 (with electrification in 1908), and modernisation in recent years has seen the arrival of five-section Pesa Swing low-floor vehicles. There is also an eight-route trolleybus operation.

Commuting from the city's hinterland includes the Szeged – Békéscsaba railway, with an hourly service of diesel railcars. Most traffic is between Szeged and Hódmezővásárhely, with passengers alighting at Szeged-Rókus or Szeged Pályaudvar, offering transfers to tramline 1 to reach the city centre.

In 2016 a scheme was approved to build an 800m electrified tramway link from the terminus of line 1 at Szeged Pláza to Rókus station. This would allow the introduction of a tram-train service over the non-electrified railway (renovated to permit a higher line speed of 100km/h). In Hódmezővásárhely 3.3km of single-track tramway would take passengers from Népkert station into the town centre. A 30-minute peak service is planned.

The initial budget of HUF23.5bn (EUR74.78m in 2016 prices) has ballooned to over HUF80bn (EUR222m in 2020), largely due to the cost of refurbishing the rail line increasing to HUF48.5bn (EUR137m). There has been political criticism of the National Infrastructure Development Company (NIF Zrt) for its handling of the procurement process.

Work on the project began in April 2018 and eight 37.2m electro-diesel Citylink LRVs were ordered from Stadler Rail Valencia for HUF16.7bn (EUR47.2m), each fitted with two low-emission 390kW diesel engines. An option for a further four



vehicles was exercised in June 2020. Each tram-train has capacity to carry 220 passengers (92 seated) and will be operated by national rail operator MÁV-START. It is hoped to inaugurate the service in the summer.

The first trials on the new tramway took place on 2 December using Szeged works tram 03.

OPENING IN 2021 - SPAIN

Spain is another nation with a rich tramway heritage, although almost all of its first-generation lines had disappeared by the late 1960s. Closures came on a common basis with other European cities over claims that trams hindered traffic flows in an age of increasing automobile ownership. Only two survived (Barcelona's Tramvia Blau and Majorca's Tranvía de Sóller, both now reduced to short tourist lines using heritage rolling stock).

From the 1990s, plans were developed to reintroduce tramways to key cities, with the first (Valencia) opening in 1994. This has since tripled in size and is incorporated into a wider integrated network of metro and suburban rail lines. A number of modern city tramway networks were installed over next two decades (Zaragoza being the latest as the Jaén tramway never reached full commercial opening), although the fallout of the 2008-09 financial crisis saw many future projects cancelled or postponed.

In Cádiz, the Bahía de Cádiz tram-train project dates from 2008 and involves 10.3km of shared track with RENFE broad-gauge trains from the city station at Plaza de Sevilla to La Ardila (Río Arillo), then 13.7km of new tramway through San Fernando to La Chiclana. The depot is at La Hoya at the southern end of the line.

Built at its factory in Linares, CAF has supplied seven dual-voltage (750/3000V dc) 38.1m three-section LRVs, capable of 100km/h operation. They are a 55% low-floor design for operation on 1668mm-gauge tracks. Different door heights (760mm/380mm) accommodate both high railway platforms and lower street stops.

From a project launched 11 years ago, it had been hoped to carry passengers in 2017. However, despite 16hr/day testing there have been extensive delays (and additional expenditure of EUR116m) mostly focused on the interoperability over the ADIF section of track. This was completed in November 2020. The service will be operated by state-owned RENFE.

Looking ahead, plans exist for a second route to offer a connection to Jerez airport around 43km inland to the north-east. (Cádiz does not have its own airport).



OCEANIA

OVERVIEW

While no new systems are planned to open in 2021, Australia has seen a remarkable few years with three new tramways opening in Canberra, Newcastle and Sydney in 2019.

The successful Gold Coast tramway also opened in 2014, with major growth since (partly in response to the region's hosting of the 2018 Commonwealth Games, for which the tramway played a key transport role) – and more is planned.

Every current Australian system has expansion plans, with many of these due to be realised in the coming few years. For such a vast country with a population of just over 25 million, such commitment to sustainable transport is nevertheless impressive.

In New Zealand, long-held ambitions exist for the implementation of an LRT solution for the country's largest city and economic capital, Auckland. Proposals have seen a great deal of both forward and backward momentum, and currently the programme remains on hold, despite significant investment in studies, route design and planned procurement in recent years.



Newcastle: Opened February 2019 **9**



Canberra: Opened April 2019 **10**



Sydney CBD & South East LRT: Opened December 2019 **11**

NORTH AMERICA

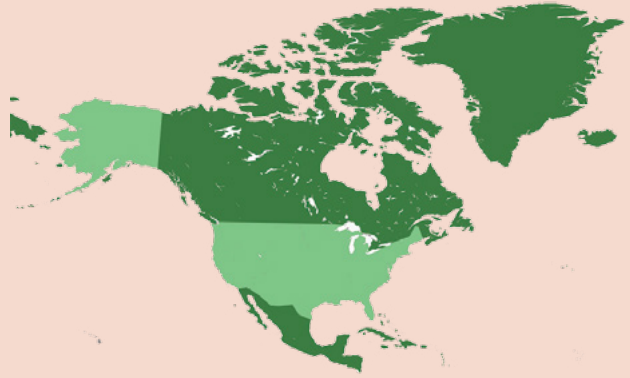
OVERVIEW

Urban rail provision in North America falls into two key and distinct categories: streetcars and light rail. Although the boundaries between the two definitions overlap, the former generally encompasses shorter routes, low-floor vehicles with more frequent stops and a high level of street-running. The latter features a majority of segregated routes, larger and often coupled (predominantly) high-floor units and longer distances between stops.

From the end of the 19th Century to the 1930s, most large cities featured a 'street railway'. Many closed during the Great Depression. World War Two saw many rerieved, but the onset of cheap automobile travel and policies leaning towards highway construction popularised in the 1950s and 1960s spelt the end for many more. A handful of survivors were retained due to the unique characteristics of their – often segregated – city routes and high ridership.

Light rail's rebirth began in the late 1970s with the importation of European 'Stadtbahn' technologies and equipment, beginning with the opening of the Edmonton (Canada) system in 1978. Due to the higher cost of construction, only four all-new light rail systems (in North American terms) have been added in the past decade, although the established lines have seen extensive expansion and modernisation.

Funding mechanisms involving both federal and local contributions have seen streetcars and 'urban circulator' systems gaining in popularity as both solutions to congestion and forming the backbone of transit-oriented development policies; 11 have opened in the 21st Century and many more are under development. Indeed, some cities feature both light rail and streetcar systems, although these are often not fully-integrated.



OPENING IN 2021 - USA

The Arizonan city of Tempe (population 195,800) is a de facto suburb of Phoenix, already served by Valley Metro light rail between the downtown and Arizona State University. This 42.3km LRT system opened in 2008, linking Phoenix with neighbouring Tempe and Mesa.

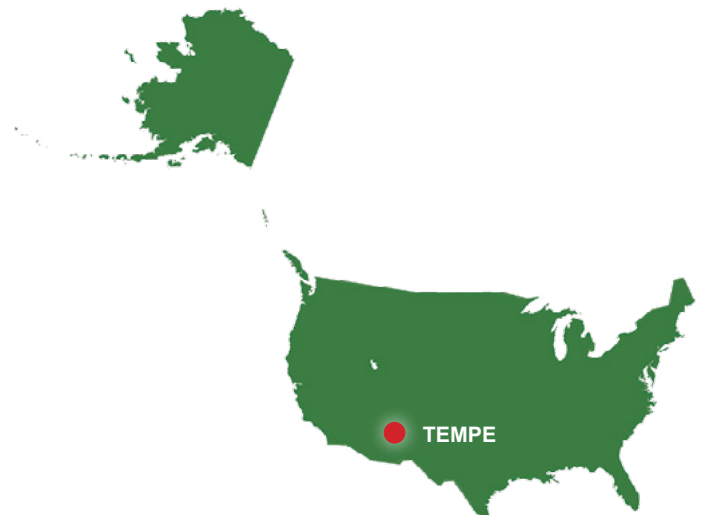
In 2017 Valley Metro and the City of Tempe began construction of a 14-stop 4.8km double-track urban streetcar line from Marina Heights via downtown to Dorsey Lane. There is an interchange with Valley Metro light rail at 3rd St and again at the eastern Dorsey Lane terminus.

Stacy & Witbeck is acting as prime contractor on the USD192m project, which is funded using local sales tax revenues and federal grants (USD75m) with USD13m coming from a public-private partnership between Tempe, Arizona State University and other property owners served by the new line.

Streetcars will not run through onto the light rail line in passenger service, but will use the existing system's tracks to travel to and from the Valley Metro depot and maintenance centre. This is being expanded under a discrete USD94.9m project to also cater for future growth of the light rail network.

A request for proposals for the supply of low-floor cars with off-wire capability attracted six responses and in June 2017 a USD33m contract for six vehicles was awarded to Brookville Equipment Corporation, which is supplying its 70% low-floor Liberty model. Onboard battery energy storage is provided for the section on downtown Mill Lane. With capacity for 125 passengers each car, Tempe is the fifth US city to choose the Liberty for its urban streetcar lines.

Main construction works are scheduled to complete at the end of March, although delays to the vehicle deliveries related to the coronavirus pandemic now suggest an opening in autumn 2021. There are plans to extend the line, perhaps in partnership with neighbouring Mesa, with corridors identified for investigation.



12

SOUTH AMERICA

OVERVIEW

South American nations were relatively late to the modern light rail revolution, and even now the limited development seen has been focused on the continent's two dominant nations, Brazil and Argentina. The latter's systems primarily use repurposed former rail alignments and utilise refurbished or second-hand rolling stock from other systems.

A demonstration low-floor project in an eastern suburb of Buenos Aires (Argentina) ran between 2007 and 2012 but closed due to lack of patronage. The corridor has since been allocated to highway construction and the equipment moved to the city's 'PreMetro' lines.

In Brazil, the Santa Teresa Tram first-generation survivor is now primarily a tourist route, although a serious accident in 2011 saw the line closed for many years. It reopened in stages with full service only achieved in early 2019.

The award of the 2014 FIFA World Cup and 2016 Olympics and Paralympics saw a flurry of plans for the installation of modern low-floor systems, but only two achieved full commercial opening: Rio de Janeiro and Santos. Both have since struggled to attract ridership near their projected numbers. A similar project in Cuiabá began construction, but has since stalled, mired in controversy, and further lines for Cuiabá and Salvador are planned but have not reached fruition.

Cuenca is continent's newest LRT system, opening for full service in June 2020. It runs north-west to south-east through the UNESCO World Heritage-listed centre (using surface current supply) of this Ecuadorian city which is situated high in the Andean mountain range.



OPENING IN 2021 - BOLIVIA

The fourth-largest city in Bolivia, Cochabamba is built in a valley in the Andes and has a population of 630,500 (with around two million in the wider metropolitan area) who enjoy the 'eternal spring' climate.

There is a comprehensive bus network, but the city is suffocating from traffic congestion and the associated deterioration in air quality. To alleviate these issues, work began in August 2017 on a 42.2km three-route light rail system known as 'Mi Tren' to connect the municipalities of Sipe Sipe, Colcapirhua, Vinto, Sacaba and Cercado.

The nation's first modern LRT network will link the city's railway station with San Simon university (Red Line, 5.2km with six stops), El Castillo (Yellow Line, 10km with 11 stops) and Suticollo (Green Line, 27km with 19 stops), partly on elevated infrastructure. A further 7.2km of track is being built for access to and around the depot. Credit Suisse is providing project finance.

Stadler Rail was awarded a contract for 12 three-section low-floor trams in 2018. Built in the company's factory in Minsk, Belarus, to the Metelitsa design (already operating in St. Petersburg, Russia), the 33.76m units are capable of 80km/h (50mph) operation and can carry 221 passengers (66 seated). Maintenance and spares provision for period of three years is included in the contract.

After delivery through the Chilean port of Iquique, trial runs began in September 2019, but trackworks ceased shortly afterwards with reports of delayed payments between the project promoters and key contractors. As such, passenger service was not achieved in August 2020 as forecast; the city has also been one of the hardest-hit in Bolivia by the coronavirus, compounding the delays. The original cost forecast of USD447.6m has now reportedly increased to USD542m.

Following the commitment of new funding from the state, construction restarted in December 2020 and work on the Red Line is most advanced (92% complete), with the Green Line



at 70% and 25% for the Yellow Line. Delays to the Yellow Line are ascribed to the lack of a final design due to objections from residents, and three alternatives have already been rejected.

It is hoped to open the first two lines by the end of 2021.

TRAMWAY AND LIGHT RAIL OPENINGS 2015-2020

The great global renaissance can trace its roots to the late 1970s, but it took another decade for the concept gain popularity: 41 systems opened between 1985 and 2000, and since the turn of the 21st Century a further 160 have been added.¹³

Although the term 'light rail' is sometimes confusing – this is especially true in Asia and Africa, where the division between systems and technologies is often problematic – for the purposes of this paper we have used a common definition that refers to rolling stock with lighter axle loads than railways or metro systems (in the range of 10-14t).

However, the concept encompasses many other features that make it attractive to transit authorities and city planners alike:

- Modular construction allowing for incremental development
- Ease of scalability and upgradability to suit growing demand
- Adaptability to local environments and ease of integration into urban centres where required.

In terms of new track kilometrage over the last five years, Europe still leads the way due to the many extensions to existing

systems. These can be developments into new areas or, as is often the case, the renewal of long-closed routes through the installation of new infrastructure and investment in new fleets.

The kilometrage shown in the table below is the current length of each system, as many have opened in phases or implemented extensions within a couple of years of initial opening. Indeed, it is often the case that retaining key contractors and suppliers maintains economies of scale and avoids the need for complicated and time-consuming re-procurement processes.

Across every continent, many of the systems listed are in a seemingly constant state of development. Network expansion in Europe and North America is often slower moving than in Asia and Africa, but ambitions remain for many cities once they have opened their 'starter lines'.

In the last decade, many tramways have doubled in size (or more) and although we haven't focused on extensions or expansion within this paper, this proves the popularity of the mode and the benefits as highlighted.

City	Country	Opening	Current length	Type
AFRICA				
Addis Ababa	Ethiopia	2015	34.3km	Light Rail
Sidi Bel Abbès	Algeria	2017	13.8km	Tramway
Ouragla	Algeria	2018	9.6km	Tramway
Sétif	Algeria	2018	15.2km	Tramway
Port Louis – Rose Hill	Mauritius	2019	13km	Light Rail
ASIA				
Huai'an	China	2015	20.1km	Tramway
Qingdao	China	2016	8.8km	Light Rail
Beijing (Xijiao)	China	2017	8.8km	Tramway
Kaohsiung	Taiwan	2017	12.8km	Light Rail
Izmir (Karşıyaka)	Turkey	2017	8.8km	Tramway
Izmit	Turkey	2017	9.2km	Tramway
Shenzhen	China	2017	11.7km	Tramway
Tangshan	China	2017	13.8km	Tramway
Wuhan (Auto City T1)	China	2017	16.8km	Tramway
Zhuhai	China	2017	8.8km	Tramway
Chengdu	China	2018	39.3km	Tramway
Shanghai (Songjiang)	China	2018	30.6km	Tramway
New Taipei (Danhai)	Taiwan	2018	7.3km	Tramway
Izmir (Konak)	Turkey	2018	12.8km	Tramway
Wuhan (Guanggu)	China	2018	36.4km	Tramway
Doha (Education City)	Qatar	2019	2.4km	Tramway
Doha (Msheireb Downtown Streetcar)	Qatar	2019	2km	Tramway
Foshan (Gaoming)	China	2019	6.6km	Tramway
Sanya	China	2020	8.4km	Tramway
Guangzhou (Huangpu)	China	2020	14.4km	Tramway
Mengzhi (Honghe)	China	2020	13.3km	Tramway
Tianshui	China	2020	12.9km	Light Rail
Beijing (Yizhuang)	China	2020	11.9km	Tramway

(continued overleaf) >>

TRAMWAY AND LIGHT RAIL OPENINGS 2015-2020

City	Country	Opening	Current length	Type
EUROPE				
Olzstyn	Poland	2015	11km	Tramway
Palermo	Italy	2015	23.3km	Tramway
Aarhus	Denmark	2017	110km	Tramway / Tram-Train
Granada	Spain	2017	15.9km	Tramway
Luxembourg City	Luxembourg	2017	7.1km	Tramway
Paris T11	France	2017	11km	Tram-train
Sheffield - Rotherham	UK	2018	5.5km	Tram-Train
Avignon	France	2019	5.2km	Tramway
Caen	France	2019	16.2km	Tramway
Utrecht (Uithoflijn)	Netherlands	2019	8km	Tramway
Lund	Sweden	2020	5.2km	Tramway
Istanbul (Golden Horn)	Turkey	2021	8.8km	Tramway
OCEANIA				
Canberra	Australia	2019	12km	Tramway
Newcastle	Australia	2019	2.7km	Tramway
Sydney CBD & SE LRT	Australia	2019	12.7km	Tramway
NORTH AMERICA				
Dallas Streetcar	USA	2015	3.9km	Tramway
Cincinnati	USA	2016	5.8km	Tramway
Kansas City	USA	2016	3.5km	Tramway
Washington, DC	USA	2016	3.9km	Tramway
Detroit	USA	2017	5.3km	Tramway
El Paso	USA	2018	7.7km	Tramway
Milwaukee	USA	2018	3.4km	Tramway
Oklahoma City	USA	2018	7.8km	Tramway
Ottawa (Confederation Line)	Canada	2019	12.5km	Light Rail
Waterloo - Kitchener (ION)	Canada	2019	19km	Light Rail
SOUTH AMERICA				
Medellin (Ayacucho Tram)	Colombia	2015	4.3km	Rubber-tyred tram
Santos (Baixada Santista VLT)	Brazil	2016	11.5km	Light Rail
Cuenca	Ecuador	2020	10.2km	Tramway

Source: Mainspring LRT Monitor data and additional Mainspring Knowledge research

BEYOND 2021

The implementation of new LRT projects in the short- to medium-term will be driven by environmental imperatives, job creation and social mobility as much as any of the other factors. As cities have benefited from improved air quality during 2020, public pressure is building to clear congested urban environments. Steel wheel-on-steel rail transit systems are a clear route to achieving this aim. There are also encouraging signs that the market will continue to grow in developing nations where urban population pressures are highest and inward investment is required the most.

Fixed-track systems are not the optimum solution for every town and city however, and robust business cases and relative population sizes and projected urban growth must be taken into account. The majority of towns and cities in France, Germany, Spain and The Netherlands, for example, which could reasonably justify a tram or light rail installation already have one. Scandinavia and Nordic countries show signs of development, although again only in regions of a certain size.

The UK has strong potential for growth, and there are many obvious population centres large enough to support a tramway. The next 'new' scheme involves the conversion of heavy rail lines in and around the Cardiff City Region using tram-train technology to extend rail services onto city streets. Studies are also underway for the city of Leeds – currently the largest city in Western Europe without a mass transit system – and the wider West Yorkshire region.

In North America, the days of expansive (and expensive) 'light rail' systems may be dwindling, but the popularity of the urban streetcar as a 'passenger accelerator' and driver of Transit Oriented Development is still strong. This is evidenced in New York, Chicago, Riverside and Santa Ana, where streetcar schemes are in various stages of planning and development to underpin growth, drive regeneration and often to support more intensive and established metro rail systems.

This model is mirrored in Asia, where light rail is being employed as feeder networks to support urban expansion, driving modal shift away from private car transport and onto arterial metro routes. This is particularly notable in China, East Asia and MENA countries. Whether state finances and changes in policy will allow many of the proposed schemes to be realised in the latter is still to be seen.

Beyond new systems there is vast potential to expand existing routes to new areas. Major programmes in LA County (USA), Berlin (Germany), Stockholm (Sweden) and the UK's West Midlands are just a few examples where plans envisage significant growth of urban rail provision over the coming decades.

A number of technological trends will support the growth of light rail solutions. The use of onboard energy storage removes some of the complexity associated with wayside electrification, and vehicle and infrastructure lightweighting will allow for less intrusive construction. This will be enhanced by further importation of expertise from the wider transport sector.

Increasingly, shared procurement and project development will help reduce overall scheme costs, this however relies on greater regional and state co-ordination and leadership of transport policy.

ONES TO WATCH...

Mainspring Knowledge is constantly tracking urban transit development and progression around the world through its LRT Monitor series. Below are three of the most advanced projects that are planned to open in the coming years.

LIÈGE, BELGIUM

An 11.7km north-south line, 90% in reserved space, Liège's tramway will serve 21 stations, connecting the Sclessin multi-modal station (south-west of the city) to Herstal in the



north-east via the high-speed train station and Saint Lambert Square. With a projected cost of EUR429m, the line is planned to open in 2023. The city's first-generation tramway closed in 1967.

OC STREETCAR, USA

A 6.7km urban tramway that will link downtown Santa Ana and a new transit hub at Harbor Boulevard and Westminster Avenue in neighbouring Garden



Grove. Expected to open in mid-2022, this USD408m project is financed through a combination of federal, state and local match funding.

PARRAMATTA LIGHT RAIL, AUSTRALIA

In 2023, Sydney will welcome its third standalone light rail line (joining Inner West Light Rail, opened in 1997 and since expanded to 12.8km; and the CBD and SE LRT system that



opened in 2019, now covering 12.7km). Parramatta Light Rail is an AUD2.4bn (EUR1.5bn) 12km link between Westmead to Carlingford via the Parramatta CBD and Camellia, designed to serve growth in the city's western suburbs.

A 9km second phase has been proposed, although its viability has been called into question with alternatives being sought in 2021.

As a leading provider of data, market intelligence and analysis to the transport sector, Mainspring Knowledge is a specialist consultancy that connects organisations of all sizes to the vital business information they need to unlock new opportunities and forge new relationships.

Our portfolio of products and services – allied to unrivalled access to a global network of authorities, operators, opinion-formers and supply chain partners – brings people together to exchange ideas, innovation and best practice. Our expertise and insight also helps to empower organisations with the knowledge to enter, understand, and position themselves within the Light and Urban Rail market.

REFERENCES & ACKNOWLEDGEMENTS

The data and information in this paper is derived primarily from Mainspring Knowledge research and interviews, and from Tramways & Urban Transit – the world’s leading monthly resource for tramway, light and urban rail news and analysis.

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