



UNIFYING BARCELONA'S TRAMWAYS

Eduard Cabrera, Infrastructure Manager of ATM, describes how the long-awaited plan to link Barcelona's separate tramway networks will come to fruition from 2023.

The **Autoritat del Transport Metropolità (ATM)** was created in 1997 to co-ordinate the public administrations that own the public transport services and infrastructures in the Barcelona area: Generalitat de Catalunya (51%), Barcelona City Council (25%) and Metropolitan Area of Barcelona (24%). Serving a population of 5.5m, the network under the ATM's supervision has grown steadily in recent years: 1.056m journeys were made in 2019, with *Mobility Master Plan (MMP)* projections indicating that this will grow to 1.218m/year by 2025¹ and 1.451m/year by 2030².

Despite the impacts of the COVID-19 pandemic on public transport, once group immunity is achieved the ATM expects a recovery similar to the forecasts in the MMP for 2025 and 2030. Structural improvements are therefore required if we are to generate the capacity to absorb the demand for public transport and overcome the obstacles to the region's sustainable mobility policies. These improvements are foreseen in the region's *Infrastructure Master Plan 2021-2030*.²

All the mobility plans currently being approved by the different administrations involve a reduction in the use of private vehicles and the encouragement of a switch to public transport and active travel. This shift will improve air quality and contribute to the fight against climate change, as well as freeing up valuable public space as private vehicles occupy the most space per journey. Linking the existing tramway networks will make a fundamental contribution to the objectives set out in all these planning documents:

- Decongesting the bus network, especially the 'H' (horizontal) lines of the orthogonal bus network of Barcelona
- Creating new interchanges in the central area of Avinguda Diagonal with the 'V' (vertical)

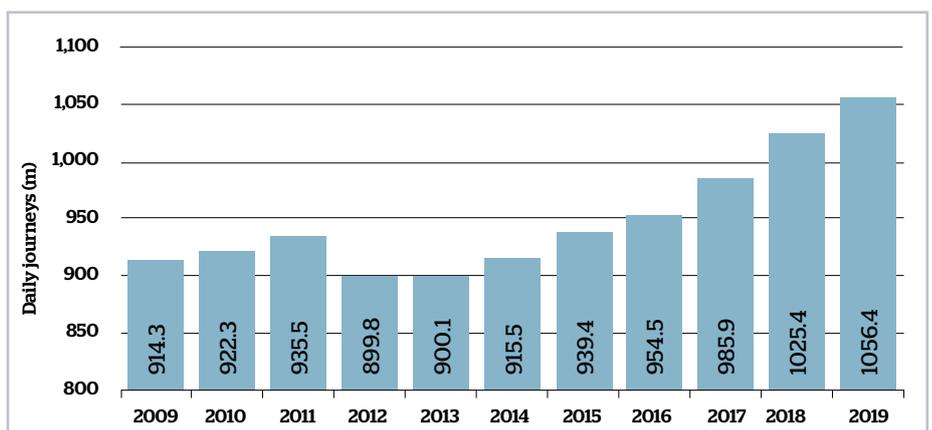
▲ The three lines of Barcelona's Trambaix tramway terminate just short of the large Plaza de Francesc Macià roundabout in the west of the city. New plans will see this network extended along Av. Diagonal to connect with the separate Trambesòs network. Falk2 / CC BY-SA 4.0

bus lines and with the metro stations operated by both Transports Metropolitans de Barcelona (TMB) and Ferrocarrils de la Generalitat de Catalunya (FGC).

- Removing the need for transfers from the Besòs – Badalona area to the Zona Universitària – Baix Llobregat, absorbing future transport growth along this corridor
- Allowing urban transformation of this avenue: from an Av. Diagonal with cars, to one focused around active mobility and public transport.

Background

Like many Western European cities, Barcelona had an extensive network of first-generation tramway lines: from animal traction at the



▲ Demand for public transport 2009-19 under the integrated fare system of the Barcelona ATM.



▲ ABOVE: An Alstom TFS tram and a Siemens Combino operated the 1997 pilot, carrying around 400 000 passengers over the 650m line with two stops. Joan Termes

end of the 19th Century; electrification, expansion and consolidation during the first half of the 20th Century (with periods of slowdowns such as during the Civil War); to decline with the expansion of automobile use from the 1960s. The last trams ran in 1971, leaving only the short 'blue' (*Tramvia Blau*) line. Although essentially a tourist line, this 1.3km (0.8-mile) route in the hilly Sarrià-Sant Gervasi district also offers a connection between the Avenida Tibidabo of Metro line L7 and the Tibidabo funicular. From here passengers can explore the Collserola mountain range, a green oasis and a popular destination for Barcelona residents.

Barcelona's tramway system currently comprises two unconnected networks: Diagonal – Baix Llobregat (Trambaix) and Sant Martí – Besòs (Trambesòs). Re-introduction of the mode began in the late 1980s, when a tramline was planned to serve the city's Avinguda Diagonal. This key thoroughfare was designed by renowned engineer Ildefons Cerdà in the famous Eixample district and

runs for 10km (six miles), crossing the city from south-west to north-east.

A 1997 pilot project employed a single 650m track connecting Plaça Maria Cristina and Plaça Francesc Macià, on which two different vehicle types were trialled, allowing the people of Barcelona to familiarise themselves with the concept of a modern tramway.

In 1998 the Generalitat de Catalunya delegated the powers for the installation of tracks in the Diagonal – Baix Llobregat corridor to the ATM and later, in 2001, the corresponding powers for a system in the Diagonal corridor (Plaça de les Glòries – Besòs).

In the spring of 2004, both systems began their first phase of commercial operation and after successive phases of expansion, the current configuration was completed in 2008.

These networks signified a paradigm shift in mobility for the municipalities served, eliminating or narrowing highway lanes and reducing road traffic. Both projects also included significant 'façade to façade' improvements to the urban realm.

The tramway has been a great success, especially the Trambaix network which has required an additional four trams – introduced in 2011 – to address capacity issues during the morning rush hour.

Connecting the tramways

A Trambaix-Trambesòs link featured in the 2001-2010 IMP and subsequent versions, although doubts persisted within about its implementation. Finally, in 2016, Barcelona City Council and the Generalitat de Catalunya agreed to advance the project, at which time the Generalitat commissioned the ATM to start preparatory works.

This agreement allowed the ATM to start work in 2017 on drafting the 'Informative Study'³, with the co-operation of Barcelona City Council, analysing four alternatives for connecting the two networks: a surface route on Av. Diagonal; a partial underground section between Francesc Macià and C.Bruc; a surface route on Carrers Urgell – Provença and Av. Diagonal; and finally, an electric bus line.

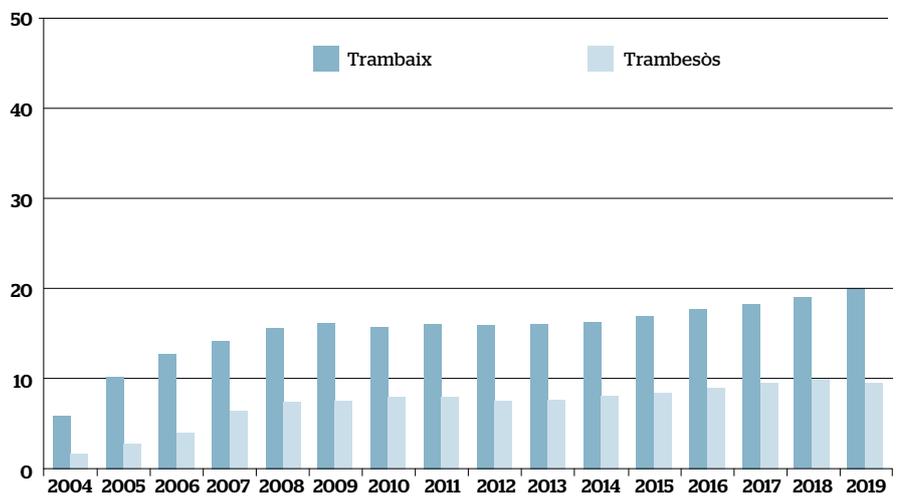
The study recommended the first option, a surface tramline, to encompass the greatest social, environmental and economic benefits. Demand estimates forecast 117 000 new users each day, almost doubling the existing ridership on both networks.

The study also indicated that 84% of users of the future unified network would be existing public transport passengers, with the remaining 16% being new users. Without considering existing tramway passengers and those who already walk or cycle – all of which are considered sustainable trips – the additional demand for public transport accounts for almost 12% (6.6% private vehicle users and 5.3% new users), reinforcing the strategic commitment to combat climate change and improve urban air quality.

The nature of this expected increase makes this project one of the most important in the Barcelona area, alongside the completion of Metro line L9 and the extension of L8 between Plaça d'Espanya and Gràcia stations.

The performance of modern tramways, characterised by segregated services, traffic light priority, regularity, commercial speed, accessibility and comfort, is not the only reason for these figures. On the one hand, currently public transport in this section of Av. Diagonal is provided only by crowded bus lines which suffer from low commercial speed due to traffic congestion. Moreover, bus service is almost non-existent between Passeig de Gràcia and Plaça de les Glòries;

2019 DATA	TRAMBAIX	TRAMBESÒS
Lines	3 (T1-T2-T3)	3 (T4-T5-T6)
Network length (km)	15.1	14
Stops	29	27
Vehicles	23	18
Trams/direction (peak)	15	8
Vehicle-km	1 512 195	1 030 952
Commercial speed (km/h)	17.63	17.67
Total journeys	20 219 502	9 543 665



▲ Evolution of demand on Barcelona's tramway networks.

the new tram connection will provide a new offering for this important corridor.

On the other hand, the surface tramway option along Av. Diagonal will promote modal integration with the bus network, mainly the vertical 'V' lines, and the railway. New interchanges will be created with Metro L1 – Glòries, L2 – Monumental, L3 – Diagonal, L4 – Verdaguier, L5 – Verdaguier and Diagonal) and Provença and Francesc Macià in the future extension of FGC-operated L8, thus boosting the overall network.

Connection characteristics

The planned 4km (2.5-mile) link will feature six new stops and relocation of the existing Glòries stop, offering 15-minute journeys between Glòries and Francesc Macià at an estimated commercial speed of 16-17km/h (10-10.5mph). Implementation will be divided into three sections: Francesc Macià – Passeig de Gràcia (recently developed in 2015); Passeig de Gràcia – Marina; and Marina – Castillejos, where the previous section will change to accommodate a central boulevard.

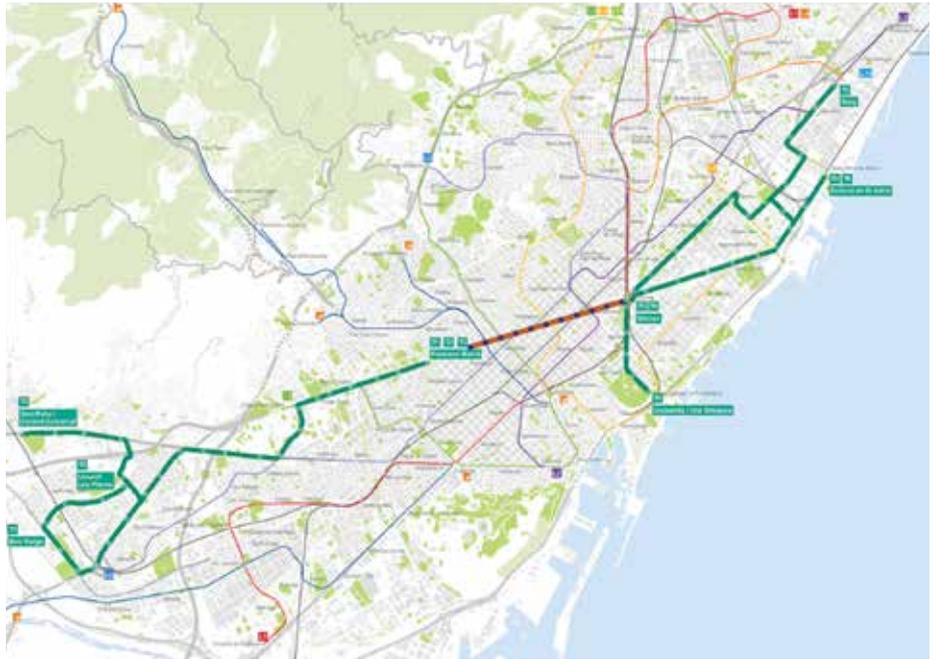
It is important to highlight the urban transformation element of this project. Development, promoted by Barcelona City Council and carried out in co-ordination with the tramway expansion, will return valuable space to the city's citizens. Pavements will be widened for pedestrians, and new cycle lanes will be added, reducing pollution, noise and vibration, and making Diagonal Avenue a cleaner, more friendly space. Plaça de les Glòries will feature a large park, the Canòpia Urbana, with a sub-surface transport hub that will include a tramstop.

Three passing lines from Plaça Francesc Macià will provide four-minute headways during weekday peak hours. These lines will branch from the future interchange at Plaça de les Glòries to the municipality of Badalona along Gran Via and to the municipality of Sant Adrià de Besòs along Av. Diagonal.

The importance of seamless integration within this emblematic Barcelona corridor, coupled with extensive intersections, has driven the decision to adopt a catenary-free electrification system. A number of solutions were investigated by the Informative Study, from continuous surface current collection to onboard energy storage, and a committee of experts conducted an exhaustive analysis that concluded that the best alternative was 'third rail' feeding technology.

This is an important technological challenge, involving modification of all 41 of the original Alstom *Citadis 302* trams in the existing Trambaix and Trambesòs fleets, as well as requiring a new track solution which can accommodate the third rail through which the vehicles will be fed. The new unified network will require 18 further trams, which must therefore be capable of current collection via both pantograph and third rail.

The high demand expected on the busiest central section will also require coupled operation from the beginning. Coupled trams, currently used only occasionally and mainly for sporting or cultural events, will then become commonplace. The enlarged fleet will also make modification of the workshop facilities that currently serve the 23-strong Trambaix fleet necessary, and the ATM foresees construction of additional stabling



▲ ABOVE: Barcelona's current tramway networks with Trambaix serving the western districts and Trambesòs in the east - the dotted line shows the future connection along Av. Diagonal.



▲ ABOVE: An illustration of the current transport demand (light green) and the increase in the existing sections, as well as in the future connection (dark green).



▲ ABOVE: Glòries on Trambesòs T4. This stop will be moved, allowing easier interchange with the nearby metro station. Maurits90_CC01.0

space to accommodate both these additional vehicles as well as future units.

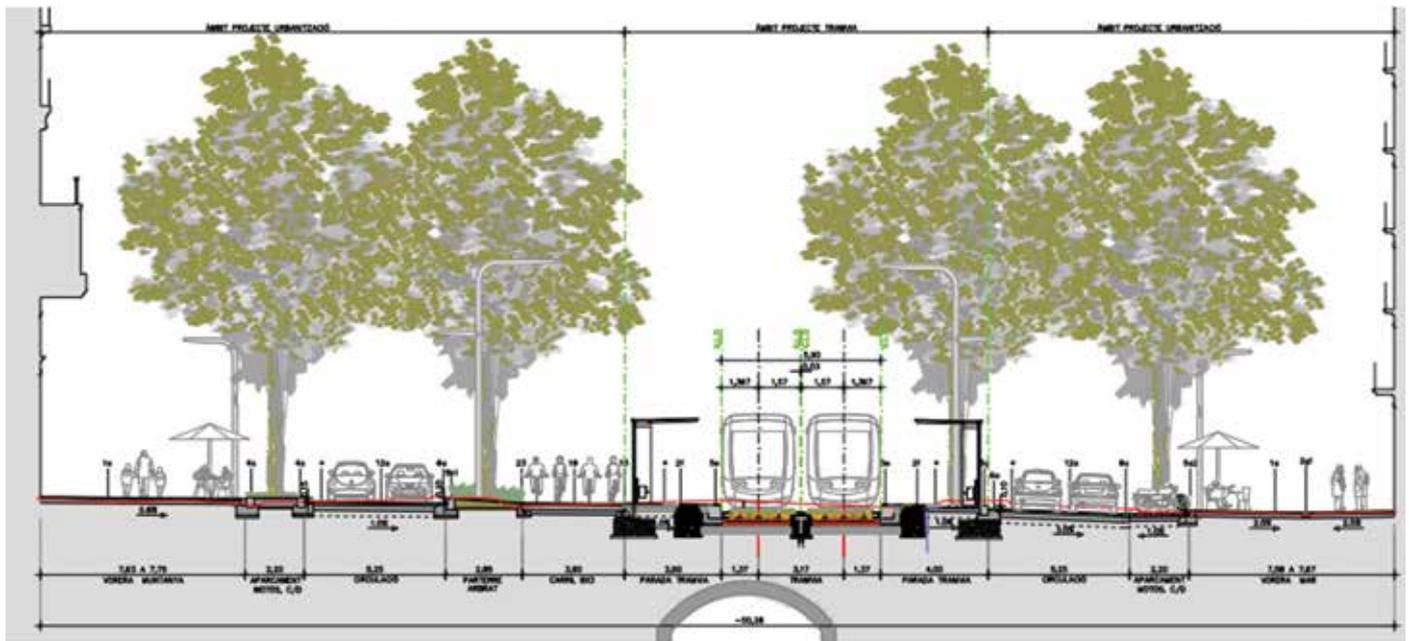
A tramway connection along Av. Diagonal will supplement the city's orthogonal bus network, mentioned earlier. Some of these bus routes will share the new tramway's route, and for this reason a shared 300m track has been designed between Via Augusta

and Passeig de Gràcia. This will have no bus stops, but shared operations between buses and guided rail vehicles represents another technological and management challenge.

From private to public

The estimated initial investment is EUR163.33m – EUR95.81m for infrastructure and tramway systems and EUR67.52m for new rolling stock and modification of the existing fleet.

Barcelona City Council and the ATM have agreed two successive development phases. First to be tackled will be the 1.8km (1.1-mile) stretch between Plaça de les Glòries and the Diagonal/Girona intersection. There will be four new stops here: Verdaguier, Sicília, Monumental and Glòries. This phase extends the Trambesòs system, connecting Glòries with the Verdaguier L4 station. The planned service consists of the current T4 line serving Av. Diagonal and the T5/T6 lines extending to Meridiana to Ciutadella/Vila Olímpica. ▶



▲ ABOVE: An illustration of how space for private vehicles will be reclaimed for the tramway along Av. Diagonal.

▼ BELOW: An artist's impression of the future tramway, showing the planned cycle lanes and widened pavements.



Three additional trams will be required for this phase, estimated to cater for over 19 000 new daily journeys. From the EUR50.37m budget, EUR36.66m is allocated to infrastructure and tramway systems and EUR13.71m for trams.

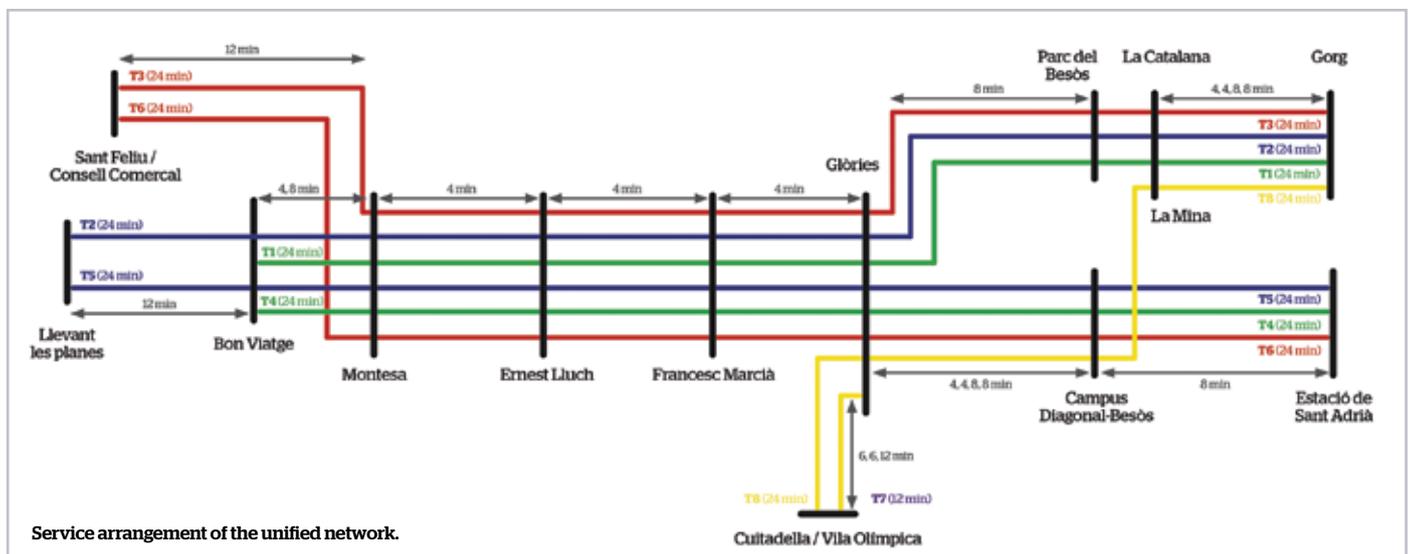
Unlike the existing networks, which were designed, built and operated through a public-private collaboration, the Av. Diagonal connection will be 100% publicly financed, through contributions by the different consortium administrations: Generalitat de Catalunya, Barcelona City Council and Metropolitan Area of Barcelona.

First phase works are expected to begin this year, with commercial service in 2023. **TAUT**

› All images courtesy of ATM unless stated.

FURTHER READING

1. *Mobility Master Plan 2020-2025*
www.atm.cat/web/ca/PDM.php
2. *Infrastructure Master Plan 2021-2030*
www.atm.cat/web/en/PDI-2021-2030.php
3. *Informative Study*: www.atm.cat/web/ca/estudis-xarxa-tramviaria.php#collapse-Three



Service arrangement of the unified network.