

Spain embraces the tram



EXPANSION Light rail has found favour with the authorities and inhabitants of many Spanish cities. Jane Pearce reviews recent development and future plans.

There has been an explosion of light rail projects in Spain over the last 20 years. The first modern tram line opened in Valencia in 1994, followed by Alacant in 1999. Eight cities followed suit in the next decade (Table I), and more lines will open in 2011 and 2012 (Table II). And there are many more to come, particularly in Andalucía, where the construction of tram networks is a key element of the region's 2007-13 infrastructure plan.

Valencia pioneers

Valencia now has a 20.7 route-km tram network operated as three lines within the city, worked by a fleet of 44 CAF 3800 and Bombardier Flexity Outlook trams (MR 9.08 p25). Line T2 is currently under construction linking Nazaret in the southeast via the city centre to El Serrans, where it will connect to T4. Further extensions north to Tavernes Publiques and west to the University of Burjassat and the Paterna district are also envisaged. Costing €475m, the line will be

7.5 km long and will run mostly underground in the city centre. It is expected to carry 25 million passengers a year. Expansion of T6 to create a fully orbital route is also on the cards.

The proposed L'Horta Sud light rail route would follow a semicircular alignment, starting at Av Valencia on the metro Line 5 airport extension and running via Torrent, Picanya and Paiporta to terminate at La Fe with interchange to metro Line 1 and T6. Several branch lines are envisaged.

The network in Alacant will reach 65 route-km when the 12 km Line 2 with 14 stops opens in early 2011. The route starts at the new RENFE station, which will become a key modal interchange, and shares three stops with lines 1, 3 and 4 before branching off after MARQ to San Vicente del Raspeig, serving the hospital and university. Construction started in December 2006 and the estimated project cost is €100m. The line may eventually be extended north to Hospital Sant Vicent and south to Babel, sharing the Line 1 extension to the airport. The neighbouring municipality of Elche

is also promoting a tram link to Alacant's central station.

The Tranvimur joint venture of Acciona and Grupo Cívica opened a 2.2 km demonstration tram line in Murcia in April 2007 using two Alstom Citadis 302 cars on loan from Madrid. The route has four stops along Avda Juan Carlos I; the trams operate every 9 min at peak hours and every 18 min off-peak.

In April 2009, the Tranvía de Murcia consortium of FCC and Comsa was awarded a 40-year contract to build, maintain and operate Line 1, which will incorporate the pilot section. The 17.5 km route with 28 stops will link the city centre with Nueva Condomina to the north and Guadalupe, via Murcia University, to the west. Work began in the summer of 2009 for completion by the end of 2010. Catenary installation started in May and should be completed this month, allowing trial running to start in November. In March the Mayor of Murcia, Miguel Angel Cámara, announced that a proposed extension south to Murcia station

Sevilla's Metrocentro line is initially being operated by light metro cars, but narrower trams with onboard energy storage for catenary-free operation are now on order.



CAF's Urbos 2 low-floor cars as supplied to Vitoria-Gasteiz have also proved popular with other Spanish cities.

would use catenary-free operation along Gran Vía.

Basque country

In Bilbao, EuskoTran has been operating a 4.9 km metre-gauge tram line with 12 stops linking Atxuri and Basurto since 2002. Work on a €5m extension to Autonomía and La Casilla commenced in July this year, but the route will not continue to Rekalde as originally planned. Rekalde will now be served by metro Line 4, and infrastructure manager Euskal Trenbide Sarea instead plans to extend the tram line from Autonomía to Pio Baroja via Zabalburu to form a loop.

The foundation stone for the €4.2m depot and works for a 3.8 km line with 9 stops from the University of the Basque Country (UPV) to Leioa was laid on July 16. The first phase is due to open in 2011-12, and a 1.8 km extension to Urbinaga is under consideration. A 6 km line with 16 stops serving Barakaldo, with an interchange to the Leioa route at Urbinaga, has progressed to the detailed design phase.

The first phase of EuskoTran's light rail line in Vitoria-Gasteiz, capital of Alava province, opened for revenue service between Angulema and Ibaiondo on December 23 2008, followed by a branch to Abetxuko on July 10 2009.

Barcelona link studied

In 2004, TRAM launched the Trambaix and Trambesós networks in Barcelona, each operated as three lines using a total of 41 Alstom Citadis 302 vehicles. A proposal to build a 3.8 km link with five stops along Avenida Diagonal to join up the networks by

2018 would form part of a project to completely remodel the road, which suffers from congestion, noise and air pollution and will not be able to handle future traffic demand.

Estimates suggest that ridership on the unified 33 km network with 61 stops would increase from 24 million passengers/year to more than 50 million. The plan envisages operation of the expanded network as four or five lines using 59 vehicles. Adding another 21 trams would allow lines T1 and T3 to be worked by pairs of cars.

Ambition in Andalucía

The Junta de Andalucía is promoting and financing the construction of tram networks in the region's eight provincial capitals, with support from the government and local municipalities. All projects are designed to be energy efficient, using regenerative braking and solar power, and all have Park & Ride facilities.

An agreement signed by Andalucía's Minister for Public Works & Transport Concepción Gutiérrez and Mayor of San Fernando Manuel María de Bernardo on November 15 2007 paved the way for tendering to begin for the 24 km Bahía de Cádiz tram-train route connecting Chiclana de la Frontera with Cádiz (RG 7.06 p493). The project is costed at €142m excluding rolling stock and includes 13.7 km of new track with 17 stops between Chiclana and San Fernando, where LRVs would join the 1668 mm gauge railway for 10.3 km to Cádiz.

CAF won a €43.3m contract in April 2009 to supply seven two-section cars,

with the first to be delivered in 22 months. The vehicles will be 37.7 m long and 2 650 mm wide with space for 238 passengers. Maximum speed is 100 km/h although average speed in the urban area will be below 30 km/h. End-to-end journey time will be 35 min, and the route is expected to carry 11 600 passengers a day.

Work on the 4 km section in Chiclana, the last to be awarded, started in March and will take 24 months. A significant milestone was reached on September 9, when installation of catenary masts started in San Fernando.

Phase II of the Cádiz tram network envisages a second route linking Cádiz, via Puerto Real and Puerto de Santa María, with Jerez de la Frontera, allowing travellers to reach Jerez airport in 39 min. The initial section in Cádiz and the final section to Jerez would share the existing railway, but the intermediate link would use a new double-track alignment on the 3.2 km La Pepa bridge currently being built across the bay of Cádiz.

The regional government awarded a contract to Ardanuy and Iberinsa in January 2008 to develop a light rail scheme in Jerez de la Frontera. Civil works and tracklaying would be funded by the region, and the municipality would meet the cost of railway systems and rolling stock. A three-line network has been proposed. Line 1 would have a 7.6 km east-west alignment with 16 stops connecting the university and the hospital via the city centre and central station. A two-month consultation process took place between February and April 2009.

Table I. Operational light rail networks in Spain

City	Length km	Lines	Stops	Gauge mm	Vehicle type	Cars	Open
Alacant	52.4	3	43	1000	Vossloh Tram-train BT Flexity Outlook	9	1999
Barcelona Trambaix	15.1	3	29	1435	Alstom Citadis 302	23	2004
Trambesós	14.1	3	27	1435	Citadis 302	18	2004
Bilbao	4.9	1	12	1000	CAF Urbos 1	8	2002
Madrid ML1	5.4	1	9	1435	Alstom Citadis 302	8	2007
ML2/3	22.4	2	29	1435	Alstom Citadis 302	27	2007
Parla	8.2	1	15	1435	Alstom Citadis 302	9	2007
Murcia	2.2	1	4	1435	Alstom Citadis 302	2*	2007
Santa Cruz de Tenerife	14.6	2	25	1435	Alstom Citadis 302E	26	2007
Sevilla Metro Centro	1.3	1	4	1435	CAF Urbos 2	4	2007
Valencia	20.7	3	43	1000	CAF 3800 BT Flexity Outlook	23	1994
Vélez-Málaga	6	1	9	1435	CAF Urbos 2	3	2006
Vitoria-Gasteiz	7.1	2	18	1000	CAF Urbos 2	11	2008

* On loan from Madrid

Table II. Spanish light rail projects

City	Length km	Lines	Stops	Gauge mm	Vehicle type	Cars	Status	Completion date
Alacant Line 2	12	1	15	1000			under construction	
Barcelona	3-8	extn	5	1435	Alstom Citadis 302		proposed	2018
Bilbao L1 extension to La Casilla	n/a	extn	2	1000			under construction	mid-2011
UPV – Leioa	3-8	1	9	1000		5	under construction	2011-12
Leioa – Urbinaga	1-8	extn	2	1000			feasibility study	
Urbinaga – Barakaldo	6	1	16	1000			project design	
Bahía de Cadiz	24	1	22	1668	CAF Tram-train	7	under construction	2011-12
Granada	15-9	1	26	1435	CAF Urbos 3 ACR	13	under construction	2012-13
Jaén	4-7	1	10	1435	Alstom Citadis	5 *	under construction	Q1/2011
Jerez de la Frontera	7-6	1	16				feasibility study	
León	9	2	4	1000	Vossloh tram-train	4	under construction	2011-12
Málaga	13-5	2	20	1435	CAF Urbos 3	14	under construction	Nov 2011
Murcia	15-3	1	24	1435	Alstom Citadis 302	11	under construction	2011
Sevilla Metrocentro	0-9	extn	1	1435	CAF Urbos + ACR	4	under construction	2010
Dos Hermanas	8-4	1	10	1435	CAF Urbos 3 ACR		under construction	2012
Alcalá de Guadeira	12-5	1	11	1435	CAF Urbos 2		under construction	2011
Aljarafe	28	1	tbd	1435			Phase 1 under construction	
Valencia T2	7-5	1	12	1000			under construction	
T6 orbital route	n/a	extn					proposed	
L'Horta Sud	n/a						proposed	
Zaragoza	12-8	1	25	1435	CAF Urbos 3 ACR	21	under construction	2011-13

* bought from Madrid

Sevilla surges ahead

Sevilla's light metro was inaugurated in April 2009 following considerable delays. In the meantime, a 1.3 km tram line known as Metrocentro opened in October 2007 between Prado station and Plaza Nueva to serve the city centre, using CAF Urbos 2 vehicles intended for the metro. Initially, the catenary had to be removed every spring for the Holy Week processions, but since April the line has been worked by a CAF tram equipped with ACR energy storage, allowing catenary-free operation. CAF is to supply four new trams by March 2011, which will be slightly narrower at 2400 mm and fitted with ACR. Work began in 2009 on the first section of Metrocentro's southern extension, adding 900 m to San Bernardo at a cost of €4.95m, but this is still not open.

Three more tram lines will eventually serve as feeders to the metro, of which the €135m Alcalá de Guadaíra project is the most advanced. This 12.5 km line with 11 stops, linking the eastern district of Montecarmelo to Line 1 at Pablo de Olavide, is due to open in 2012. Construction has been divided into three sections; work on the first two, totalling nearly 9 km, started in February 2008 and has reached the tracklaying stage, with completion expected by early

2011. Construction of the third section from Technology Park to Pablo de Olavide commenced in March and is scheduled to take 20 months. Offering a journey time of around 25 min, the line is expected to carry 5 million passengers a year.

The Dos Hermanas route will start from the metro terminus at Olivar de Quintos and run south for 8.4 km with 10 stops to Las Torres/Ciudad Blanca. Funding for the €80m project was approved in April 2009, when a €28m contract was awarded for construction of the 5.1 km six-stop section from Olivar de Quintos to Casilla de los Pinos. The €18.3m contract to build the remaining 3.3 km stretch along the NIV highway was awarded in May 2010, but the E&M equipment has yet to be tendered. The route is expected to carry 3 million passengers a year when it opens in 2012.

Ciudad Expo, the western terminus of Line 1, will provide a connection to the 28 km Aljarafe tram line, which runs from Coria del Río in the south to Valencina de la Concepción and Salteras in the north. Detailed design and implementation has been divided into four sections. The 4.8 km between Mairena del Aljarafe and Bormujos is under construction and other civil works contracts are being tendered. Anticipated ridership on this line is 5.8 million passengers a year.

Málaga digs deep

A 13.5 km two-line network with 20 stations is under construction in Málaga (MR 6.09 p14). Tracklaying started in September on the 3.6 km branch of Line 2 between Héroe de Sostoa and Martín Carpena, which is expected to open in November 2011.

The Minister of Public Works & Housing, Rosa Aguilar, announced in March that stations will be fitted with platform screen doors; the installation of E&M equipment began in May, involving 20 suppliers and an investment of €153m. The final alignment for the 1.6 km underground section in

The Juan de Borbón stop takes shape for the light rail line in Murcia, where test running is expected to begin in November.



Photo: CAF



Due for completion in 2012, Granada's 15.9 km north-south line between Albolote and Armilla mainly runs at grade on a reserved alignment.

the city centre was presented in July, and this is expected to take 38 months to complete at a cost of €125m. The line will tunnel under the Guadalmedina river to serve La Marina station at a depth of 15 m, and La Malagueta at 11 m below ground.

Work on Granada's €450m light rail line started in April 2007, and this is due for completion in 2012. The 15.9 km north-south route starts at Albolote and passes through Maracena and the city centre to Armilla. The line runs mostly at grade on a reserved alignment, apart from a 2.7 km cut and cover section with three stops between Universidad and Hípica. The control centre and a depot accommodating up to 33 trams are under construction at Maracena.

The CAF-Santana joint venture in Linares was selected in April to supply 13 low-floor trams with ACR energy storage to work the Granada line. The €43.9m contract specifies delivery within 26 months and includes maintenance and an option for four more vehicles. The bidirectional trams will be 30 m long and 2 600 mm wide with a total capacity of 200 passengers. The trams will operate using a 750 V DC overhead power supply but will switch to ACR for catenary-free operation on four separate sections totalling 4.7 km. Top speed will be 70 km/h.

Alstom and Inabensa are responsible for electrification, while signalling, ticketing and communications equipment worth €31.2m is being supplied by Siemens, Acisa and ACT Sistem. The 26 stations will have 60 m long platforms to handle trams operating in pairs, and the three underground stations at Méndez-Núñez, Recogidas and Río Genil will be fitted with platform screen doors. The route is expected to carry around 12 million passengers a year. Service frequency will

be 4 to 5 min during peak hours and 7 to 8 min off-peak, and end-to-end journey time will be about 40 min.

Jaén's €78m tram project got underway when the first stone was laid on April 14 2009. A joint venture of Alstom, Gea 21, Inabensa, Mipelsa and Pavimentaciones Morales (RG 3.09 p16) was selected to build a 4.7 km route with 10 stops linking the city centre and the northern district of Vaciacostales. Tracklaying and catenary installation are in progress and station construction has commenced. A depot and control centre are under construction in Vaciacostales. Alstom is supplying five low-floor Citadis trams at a cost of €44m. With space for 154 passengers, the trams will run at 10 min intervals. The line is on schedule to open in early 2011, and it is expected to carry around 13 000 passengers each day.

Meanwhile, the Andalucía regional government is also examining the potential for light rail in Córdoba, Huelva and Almería as well as the Campo de Gibraltar area around Algeciras, San Roque and La Línea de la Concepción.

Zaragoza nears opening

Phase I of Zaragoza's first tram line is due to open in the spring of 2011. The initial route will run from north to south between Plaza Paraíso on Gran Vía and Valdespartera with 13 stops. Tracklaying is almost complete and installation of overhead wiring has commenced. Work on Phase II from Gran Vía to Parque Goya is due to start in July 2011 with opening envisaged in June 2013.

The 12.8 km project with 25 stops is being implemented by the Traza consortium of Tuzsa, CAF, FCC Construcción, Acciona, Ibercaja and Concessia,

which was selected in June 2009 to build the route and operate it for 35 years. Total project cost is €400m, including €202m for civil works and €82m for rolling stock, funded by the private partners, the municipality and the Aragón regional government.

Trams will run at 5 min intervals, using a fleet of 21 Urbos 3 low-floor cars supplied by CAF. These five-module vehicles will be 32 m long and 2 650 mm wide with a total capacity for 200 passengers. The trams will be equipped with regenerative braking and ACR to allow catenary-free operation in the city centre when Phase II opens. Average operating speed will be 19 km/h, with a maximum speed of 70 km/h. Journey time will be 21 min initially, rising to 40 min when the route is fully operational.

According to market research surveys, only 38% of the local population support the project while 51% oppose it. However, Mayor of Zaragoza Juan Alberto Belloch is convinced that within 15 days of the tram's inauguration, the city's inhabitants will be demanding a second line. In April a two-module mock-up in a red, silver grey and black livery was unveiled in the Plaza de España.

The city of León is planning to open a Y-shaped 9 km metre-gauge network connecting Puente Castro via the city centre with the residential Area 17 and the hospital. Requiring an investment of €150m, the network, is expected to carry 9 million passengers/year.

The project is to be managed by a company created by FEVE and the local government. In July, FEVE issued a tender for an €8.7m contract to convert 2.4 km of the existing León - Matalla line between the main station and the Asunción district on the northern outskirts of the city, which will have five stops. A €3.9m contract to supply electrification, signalling and communications equipment for this section was awarded to Telica SA in July.

Enabling works started on the 600 m section of new tram track with two stops between the station and Plaza de Santo Domingo in July, with completion expected by early 2011. However, work was halted in September following protests by local residents and opposition from the Junta de Castilla and León.

The third phase, involving construction of the 1.2 km branch from the university to Hospitales, is expected to cost €8.4m. Vossloh España is supplying four tram-train cars costing €17.6m to operate the route. ❏