THE DEVELOPMENT OF 1435 AND 1520 RAILWAY NETWORK CONNECTIONS IN FUTURE

POLITICAL ISSUE OR ECONOMIC BENEFIT?

Spanish Contribution

Transport & Logistics Annual Conference
“GLOBAL TRANSPORT DEVELOPMENT CHALLENGES”
Riga, Latvia, Septembre 12th 2019

Joaquín Jimenez Otero, ADIF, International Senior ViceDirector
A contribution from the Spanish experience about management of two different gauge Rail Networks

• The initial decision:
    on the HS transversal corridor Sevilla-Barcelona-French border
  ➢ 1992, new HS Line Madrid – Sevilla on service

• The big High Speed Success in Spain

• How to expand HS Success towards Conventional Network

• European Union directives (and financing)
  – Rail Market Liberalization
  – Interoperability
  – Towards a Single Railway Area

• Developing Solutions
  ➢ For Passengers & Freight
Spain’s success in High Speed Lines
**The Spanish network, a continuous evolution from 1992**

**1992** - Madrid-Sevilla: 471 km

**2003** -
- Madrid-Lleida: 468 km (200 km/h ASFA).
- Zaragoza-Huesca: 79 km

**2005/06** -
- Lleida-Tarragona: 95 km.
- Córdoba-Antequera: 100 km.
- Connection to Toledo: 21 km.

**2007** -
- Madrid-Lleida: 468 km (300 km/h from May 2007)
- Madrid-Valladolid: 181 km.
- Antequera-Málaga: 55 km.

**2008** - Tarragona-Barcelona: 88 km.

**2010** -
- Madrid-Cuenca: 183 km.
- Madrid-Albacete: 315 km.
- Madrid-Valencia: 391 km.
- Mollet – Girona: 75 km.
- Intern. Connection with France: 20 km.

**2011** -
- Ourense – A Coruña: 150 km (Iberian gauge 1.668 mm)

**2013** -
- New Connection Barcelona-French Border: 131 km

**2015** -
- Santiago C. – Vigo: 94 km (Iberian gauge 1.668 mm)
- Sevilla – Cádiz: 71 km (Iberian gauge 1.668 mm)
- Valladolid – León: 166 km
- Olmedo – Zamora: 103 km

**2018** - Valencia – Castellón: 73 km (Double gauge Standard – Iberian)

**2019** - Antequera – Granada: 122 km

**SPANISH HIGH SPEED 2018**

- 3.332 km*
- Design up to 350 km/h
- Operation 310 km/h
- 355 HS trains/day
- 38.5 M Passengers/year
- 52% of total rail passengers-km travel on HS

* Including 616 km of Conventional Lines with HS performances (Max speed 220km/h)
Total lenght of ADIF network: 15.388 km
Adif + Adif AV. Global Figures

- **Main investor in Spain,** in last 25 years (around 57 bn $)
  - In 2007-2016 High Speed: 36,000 M€ (40 bn $)
  - Conventional Rail: 6,000 M€ (7 bn $)

- **Staff:** 13,041 employees

**Managed Rail Network:** 15,388 km (9,504mi)

  - High Speed UIC gauge 1,435 mm: 2,682 km (1,666mi)
    - 100% electrified AC
  - Conventional Lines (*Iberian gauge 1,668 mm*): 11,483 km (7,135 mi)
    - Out of which 616 km (383 mi) with HS parameters
    - 80 % electrified DC
  - Mixed Gauge Network (UIC + Iberian gauge): 222 km (138 mi)
    - Out of which 34 km (20 mi) with HS parameters
    - 100 % electrified DC
  - Metric gauge 1,000 mm: 1,207 km (750 mi)

- **HS Lines under construction or project:** 2,687 km (1,670 mi)

- **Fiber Optic Network:** 17,868 km

- **Managed Traffic:** 2.1 M trains /year 5,775 trains/day
  - 198.3 M pass train-km/year 541,849 M pass trains-km/day **50,2% HSL**

- **Passengers:** 468 million passengers/year (38.5 million HS)

- **HS Punctuality:** 98.5%, second best in the world, after Japan

- **Freight:** 7,557 million net tons-km/year
HS Lines Overview 2015 - 2020 Current Works

- LAV Iberian Gauge Vigo – Santiago 94 km
- Olmedo Zamora 103 km
- Accesos a Galicia 235 km
- Navalnoral - Badajoz 164 km
- Sevilla - Cádiz 150 km
- Variante de Pajares 33 km
- Venta de Baños - Burgos 135 km
- Y vasca 175 km
- Valladolid-Venta de Baños-Palencia-León 166 km
- Navalmoral - Badajoz 164 km
- Olmedo Zamora 103 km
- Accesos a Galicia 235 km
- Toledo - Cáceres 122 km
- Antequera - Granada 122 km
- Valladolid-Legazpi 26 km
- Segovia - León 146 km
- Madrid - Segovia 151 km
- Segovia - Palencia 119 km
- Palencia - Burgos 147 km
- Burgos - Vitoria 101 km
- Vitoria - Bilbao 68 km
- Bayonne - Girona 176 km
- Girona - Barcelona 120 km
- Barcelona - Madrid 240 km
- Madrid - Valencia 300 km
- Madrid - Murcia 260 km
- Valencia - Castellón 73 km
- Alicante - Murcia 67 km
- Valencia - Castellón 73 km
- Corredor Mediterráneo 260 km
- Nuevo Túnel Atocha – Chamartín Cuadruplicación Torrejón Velasco 7 + 21 km
- Sevilla - Cádiz 150 km
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- ON SERVICE JUNE 2019

1,000 km commissioned 2015 - 2020

HS Lines

Spanish High Speed

 operating lines
lines under construction
connection between HS lines
Stations: OPPORTUNITY FOR CITIES DEVELOPMENT

- Adif has great expertise in Stations commercial management and income-generating activities.
- VIALIAs are a PPP system that provide funding for the design and construction of Stations and ensure revenues for concession holders and for Adif.

50 High Speed Train Stations + 1.900 Conventional Lines Stations

- Intermodality for Mobility
- Services for citizens
- Urban development for City
- Businesses for Rail Company & Promoters

Madrid Puerta Atocha

Cuenca Fernando Zóbel (Brunel Award 2011)

Málaga María Zambrano (VIALIA)
### Evolution of High Speed traffic: A SUCCESS TO BE CONTINUED

<table>
<thead>
<tr>
<th>Year</th>
<th>HS (AVE)</th>
<th>HS variable gauge (Talgo 200-Alvia)</th>
<th>HS Regional (AVANT)</th>
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<td>1992</td>
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**Double Gauge trains add 8.0 Millions passengers in 2018**

**Total HS passengers Grew up 63.8 % between 2012-2018**

**TOTAL HS PASSENGERS 2018**

**HS LD + HS REG + HS LD/DG**

**38.5 Million passengers**

**HS Long Distance 21.9 M passengers**

**HS Double gauge 7.7 M passengers**

**HS Regional 6.9 M Passengers**

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Source: RENFE
Impact on demand and mobility

HS generates Growth and employment
HS Madrid - Sevilla: Success from 1992, the first explotation year

34% new demand induced by High Speed

HS transfer passengers from other transport modes less respectful with environment

34% new demand induced by High Speed

New Demand
Conventional Train
Car
Plane
Bus

HS Madrid - Sevilla: Success from 1992, the first explotation year

Market share Madrid-Sevilla
HS 90,2% in 2015

FROM 1992 (25 YEARS) HS SERVICES IN SPAIN HAVE TRANSPORTED 358 MILLION PASSENGERS (90 M OF THEM ON VARIABLE GAUGE TRAINS) SAVING:
12.9 MILLION TONNES OF CO₂
2.6 MILLION TON EQUIVALENT FUEL
4.29 Billion EUR (total investments 51.76 B EUR)

HS TRAINS IN SPAIN HAVE 29% LESS ENERGY CONSUMPTION BY PASSENGER THAN CONVENTIONAL TRAINS

HS TRAINS IN SPAIN AVOID 3kg CO₂ EMISSIONS FOR EACH PASSENGER COMING FROM CONVENTIONAL TRAINS AND 31kg CO₂ FROM CAR AND PLANE AS A MEAN VALUE

RENFE’S CARBON FOOTPATH 24.2gr CO₂ / Unit Transport (56% less than 1990 figure)

Source: FFE / Transportation Research Record Review 2010
HS Lines. Benefits and Positive Impacts

High Speed rail:

- **attracts** an important percentage (> 30%) of new passengers
- **is very competitive** with regard to air in short- medium distances
- **increases its modal share** during the first 3 years up to becoming stable
- **takes up share** from the air mode and, to a lesser extent, from the private vehicle
- means more than 50% in travel time reduction with regard to the road

38,5 million HS passengers/year in Spain
52 % passengers-km are HS
HS Lines. Socio-economic Impacts

Socio-economic effects of the rail investments on GDP

- Investments Shock
- Total effects on GDP
- Effects on demand
- Effects on productivity

Sectorial effects:
- 35.7
- 34.7
- 18.4
- 5.5
- 8.3

Direct:
Resulting from purchases made by the railway or by the railway-depending economy

Indirect:
Generated by the railway or by the railway-dependent economy on the rest of productive branches

Induced:
Consequence of the consumption generated by the disposable income due to the previous effects
HS Lines. **Socio-economic Impacts**

Socio-economic impacts. SEOPAN study: fiscal return and employment created by infrastructures investment (2009).

**General employment by one infrastructure investment equivalent to 1% GDP (Spanish case):**

- 117,500 Direct employments
- 63,100 Induced employments

255 employments by 1 each km (direct + induced)
Spreading Benefits

Integration of Conventional Lines & European Dimension

Improved Conventional lines

Maximum speed  160 ➔ 200 ➔ 220 km/h
Improvement actions on conventional lines: MEDITERRANEAN CORRIDOR

**Improved lines**

**Maximum Speed**

160 → 200 → 220 km/h

**Weighted average of Maximum Speed**

197 Km/h

**207 km**

1h 16 minutes

**Average Speed**

163 km/h

**73 km**

35 minutes

**Average Speed**

126 km/h
European Dimension: Multimodal Corridors of the Core TEN T Network

RFC
Rail Freight Corridors

1. Baltic Adriatic
2. North Sea - Baltic
3. Mediterranean
4. Orient / East - Med
5. Scandinavian – Mediterranean
6. Rhine – Alpine
7. Atlantic
8. North Sea – Mediterranean
9. Rhine – Danube
Spanish Solutions
Technology to solve different gauges operation
SPAIN TRACK GAUGE INNOVATION STORY: A practical experience starting in 1968 and speeding from 1992
First step: solutions for passengers

Evolution from an initial solution designed for passenger coaches to the introduction of variable gauge also for traction axles on locomotives and EMUs/DMUs
Solutions for passengers could to be applied in a similar way to Freight + Solution to be applied on tracks

- Automatic track gauge switches for international and Spanish gauge performed at 20 km/h (Passengers*)
  
  * Similar to that applied by Talgo and RZD for Talgo Train Moscow – Berlin (1520-1435)

- Technology of three rails track for Spanish and international gauge (Freight)
Main Projects
International Gauge Implementation – France-Barcelona-Tarragona

- **In operation – 159 km**
  - Figueres-French Border – 2 x UIC
  - Mollet-Girona-Figueres – 2 x UIC
  - Castellbisbal-Mollet – Double 3 rails-track
  - PortBCN-Castellbisbal – 3 rails-track

- **Under construction – 97 km**
  - Castellbisbal-Tarragona
    - Double 3 rails-track
  - 5 sidings -750m-
  - 417 M€
Results: International Freight Rail Traffic Patterns in the Corridor

1.- Recovery of International Freight Rail Traffic on Barcelona – French Border section

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</tr>
</thead>
<tbody>
<tr>
<td>Tons</td>
<td>1.048.097</td>
<td>1.237.208</td>
<td>1.605.058</td>
<td>2.248.696</td>
<td>2.249.581</td>
<td>2.306.107</td>
<td>+120%</td>
</tr>
<tr>
<td>Trains</td>
<td>1.852</td>
<td>2.088</td>
<td>2.521</td>
<td>2.773</td>
<td>2.762</td>
<td>2.785</td>
<td>+50%</td>
</tr>
</tbody>
</table>

International Freight Trains registered at Portbou and Figueres Stations

2.- Higher Increase on Standard Gauge Freight Traffic (Barcelona-LFP-Perpignan)

<table>
<thead>
<tr>
<th>Year</th>
<th>Trains/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>227</td>
</tr>
<tr>
<td>2014</td>
<td>870</td>
</tr>
<tr>
<td>2017</td>
<td>1,118</td>
</tr>
</tbody>
</table>

2019 ➔ 27%
2020 ➔ +70% additional

765 Tons/Train Iberian Gauge
1,081 Tons/Train Standard Gauge

New container traffic service between Monzón and Lyon on standard gauge tracks

Renfe Mercancías, Terminal Intermodal de Monzón (TIM) and TP Nova have launched a new international intermodal container traffic service between Spain and France using the high-speed track and the Perthus Tunnel.

(10/12/2018) date="MsoNormal" style="text-align:justify">

Trains run between Monzón Intermodal Terminal, located in the Port of Barcelona, and the French one, the Lyon-Vénissieux terminal, from where they return also loaded with containerized goods. From the Spanish and French terminals, the containers are distributed to their final destination both by road and by rail.

This traffic, which has a load capacity of up to 72 TEUs per train, is initially a weekly service, although Renfe Mercancías plans to increase the number of trains at a later stage.

Up to 72 TEUs per train from Barcelona Port to Lyon-Vénissieux...and return...on standard gauge tracks
Adif experience: Passenger solution

- Starting 1969 Talgo coaches
- From 2007 also traction axles
- Talgo and Caf whole trainsets
- 15 changeover facilities

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>24,036</td>
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<tr>
<td>2010</td>
<td>28,540</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>2019(*)</td>
<td>&gt; 40,000</td>
</tr>
</tbody>
</table>
Interoperability:

Passenger Services by HS trains with automatic gauge changing

High Speed Lines
Conventional Lines
& HSL Ourense – A Coruña
CURRENT SOLUTION BEING DEVELOPED FOR FREIGHT

Variable gauge OGI axle for freight
Variable gauge OGI axle for freight

- 1,668/1,435 mm. Also adaptable to, 1,520.
- Maximum load up to 22.5tn/axle.
- Y21 or Y25 bogies and two-axle wagons.
- Gauge changeover process without stopping.
- Homologated by AESF (Spanish Agency for Railway Safety) for wheels 760 and 920 mm.

https://www.youtube.com/watch?v=Qekr4sKfpMo&t=1s
Variable gauge OGI axle for freight

• GAUGE CHANGEOVER Process
Variable gauge OGI axle for freight

• Status of the PROJECT

Homologation process according to the Spanish Technical Specifications for Homologation (ETH) Rolling Stock. Wagons

Laboratory Tests: carried out in Cetest.
- Axle with 920 mm wheel: 10 million of cycles
- Axle with 760 mm wheel: 10 million of cycles

On Track Tests: 500 gauge changeover processes at the Adif facility in La Gineta, Albacete.
Carried out between June 21 and 29, 2017.
Variable gauge OGI axle for freight

- **On service TESTS**
  
  - **Phase I:** 50,000 km carried out in Iberian gauge. Railway Lines 310, Stretch: Aranjuez-Cuenca and 300, Stretch: Alcázar de San Juan-La Encina. Finished in November, 2017.
  
  - **Phase II:** 50,000 km carried out in Iberian gauge and 20% in UIC gauge. Finished in April, 2018.
  
  - **Phase III:** 150,000 km test ongoing. Finish expected November 2019.

  - Iberian gauge: on Lines 310 and 300.
  - UIC gauge: on High-Speed Line Madrid-Valencia-Alicante, between Valdemoro AV and Monforte del Cid.
Many thanks for your attention

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