



GOBIERNO
DE ESPAÑA

MINISTERIO
DE FOMENTO

Para que puedas llegar



ADIF EXPERIENCES ON HIGH SPEED NEW LINES

**Visit of a Czech delegation
about HS new project in Czech Republic**

Madrid, 26th November 2015



ACRI



- Adif Background and Figures
- Spain's success in High Speed Lines
- Construction & Maintenance costs of Spanish High Speed Lines
- Spanish technology
- Global reach



Adif Background and Figures



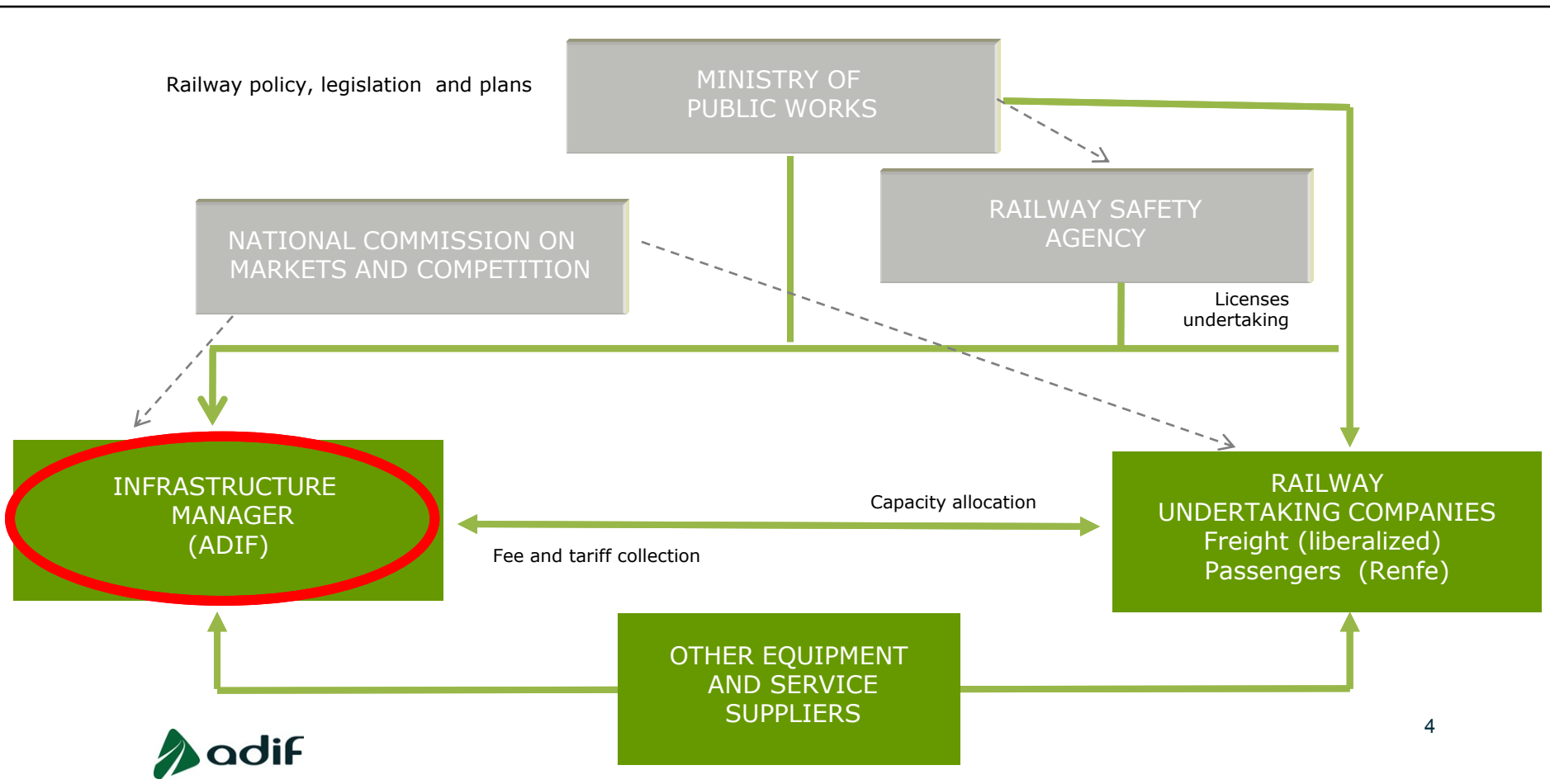
Background. Current Railways Scenario in Spain

■ NEW LEGAL FRAMEWORK. RAILWAYS ACT (2003) AND ULTERIOR

- In 2005, the National Railways company, RENFE, splits into Adif (the Infrastructure manager) and RENFE Operadora (railway undertaking in charge of transport operation, both passengers and freight).

Both companies remain 100% state-owned.

- Opening of rail freight (2007) and passengers (2013) traffics to competition



Background. Current Railways Scenario in Spain

- **STRATEGIC FRAMEWORK:**

- Transport and Housing Infrastructures Plan PITVI 2012-2024.
Over 50.000 M€ for railways, 39% of global investments

- **FINANCING FRAMEWORK :**

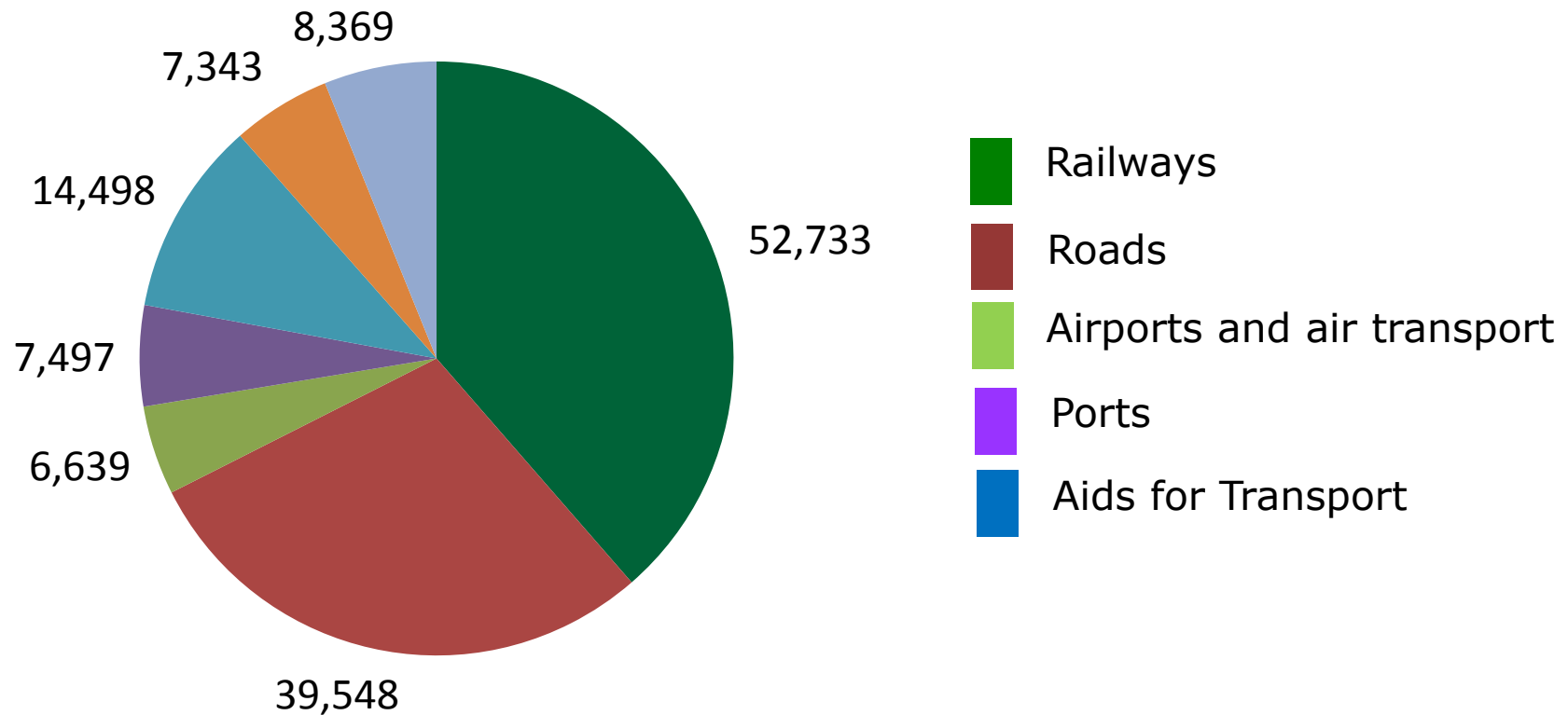
- State Resources
- EU Funds
- Private Debt

- **New European Accounting Rules** -ESA 2010- to be implemented before Sept-2014

February 2013: Ownership of
Conventional Network

August 2013: Full liberalization
Passenger traffic open to competition

January 2014: New structures
Two companies: ADIF &
ADIF AV Ownership of HSL



Railways in Spain. Investments / State General Budget 2016

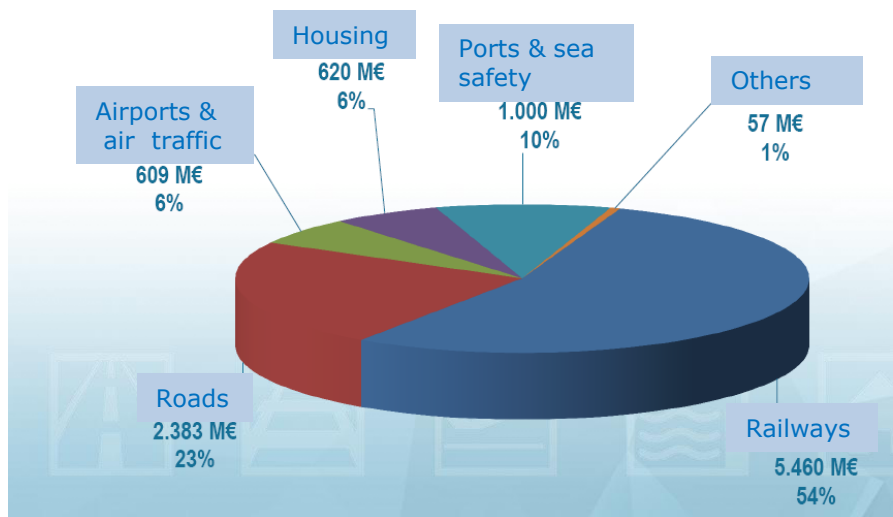


La **inversión total** del Grupo Fomento es de **10.129 M€**, lo que supone un crecimiento del **5,8% respecto a la inversión del 2015**

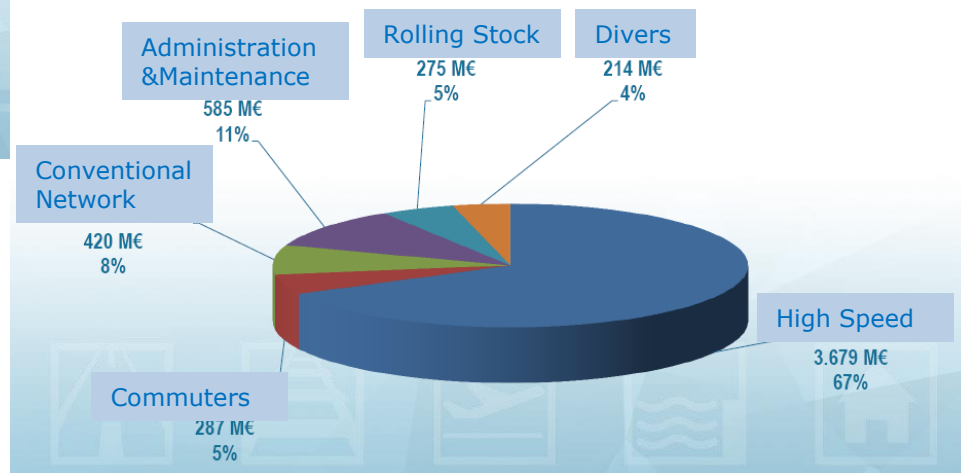
**TOTAL INVESTMENT
MINISTRY OF FOMENTO
10.129 M€ (11,44 bn \$)**

**TOTAL INVESTMENT IN RAILWAYS
5.460 M€ (6,15 bn \$) 54%**

**Of which HIGH SPEED
3.679 M€ (4,14 bn \$) 67%**



La **inversión total** destinada a ferrocarriles es de **5.460 M€**, lo que supone un **5% de incremento**. Se distribuye del siguiente modo:



Adif & Adif AV are public entities attached to Ministry of Transport & Public Works

Management

- Railway network of general public interest on Iberian or metric gauge
- High Speed Network on Standard UIC gauge
 - Madrid- Sevilla
 - HS network built by Adif
- Stations and logistic centres
- Telecommunication networks

Madrid - Toledo
Madrid - Barcelona- French Border
Madrid - Valladolid - León
Córdoba - Málaga
Madrid - Cuenca-Valencia/Albacete
-Alicante



Adif. Functions

Including both companies

ADIF for Conventional Lines + services to **ADIF AV**
ADIF AV for High Speed Lines

- Administration, maintenance and renewal of the rail network , including Passenger Stations, Freight Terminals and Telecommunications
- Construction of new lines when commissioned
- Management of traffic operations
- Network Statement
- Capacity allocation to railway undertakings
- Collecting fees and charges for the access and use of infrastructure, stations and terminals



Adif + Adif AV. Global Figures

- **Main investor in Spain, in 10 years 2005/2014** 42,000 M€ (more than 47 bn \$)

High Speed:	36,000 M€ (40 bn \$)
Conventional Rail:	6,000 M€ (7 bn \$)

- **Staff:** 14,000 employees
- **Assets:** > 55,000 M€ (62 bn \$)
- **Managed Rail Network:**

15,296 km (9,504mi)

High Speed UIC gauge 1,435 mm : **2,487 km (1,546mi)**

Conventional Lines (Iberian gauge 1,668 mm): **11,483 km (7,135 mi)**
Out of which 616 km (383 mi) with HS parameters

Mixed Gauge Network (UIC + Iberian gauge) **119 km (74 mi)**
Out of which 22 km (13 mi) with HS parameters

Metric gauge 1,000 mm: **1,207 km (750 mi)**

- **HS Lines under construction or project:** 2,878 km (1,788 mi)
- **Fiber Optic Network:** 17,868 km (11,100 mi)
- **Stations:** > 1,900 stations
- **Managed Traffic:** 2.1 M trains /year
- **Passengers:** 468 million passengers/ year (30 million HS)
- **Freight:** 7,567 million net tons-km/year
- **HS Punctuality:** 98.5%, second best in the world, after Japan



Spain's success in High Speed Lines



HS Lines. Spain's achievements

- Spain runs a top quality, safe and reliable HSR network, with the most advanced technology



HS Lines. Landmarks

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)

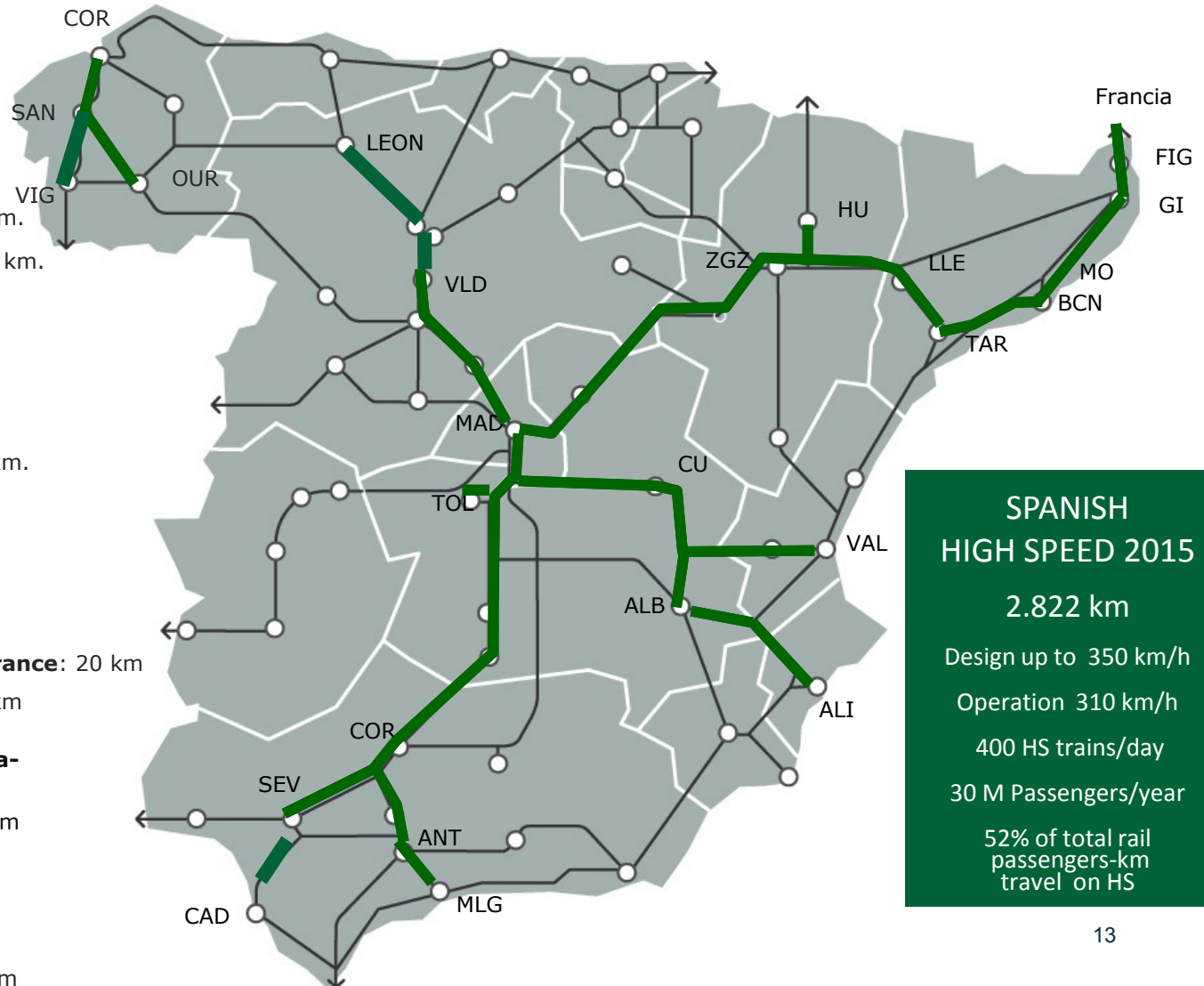
2013 - **New Connection Barcelona-
French Border** 131 km

Albacete – Alicante: 165 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



SPANISH
HIGH SPEED 2015

2.822 km

Design up to 350 km/h

Operation 310 km/h

400 HS trains/day

30 M Passengers/year

52% of total rail
passengers-km
travel on HS

Improvements with respect to historic lines

Reducing lengths, and journey times

HISTORIC LINE

(since 1884)

LENGTH: 83 km

SPEED: 70-80 km/h

JOURNEY TIME: 55'

BIGGEST TUNNEL:
LA PERRUCA (3,071 m)

NEW HS LINE

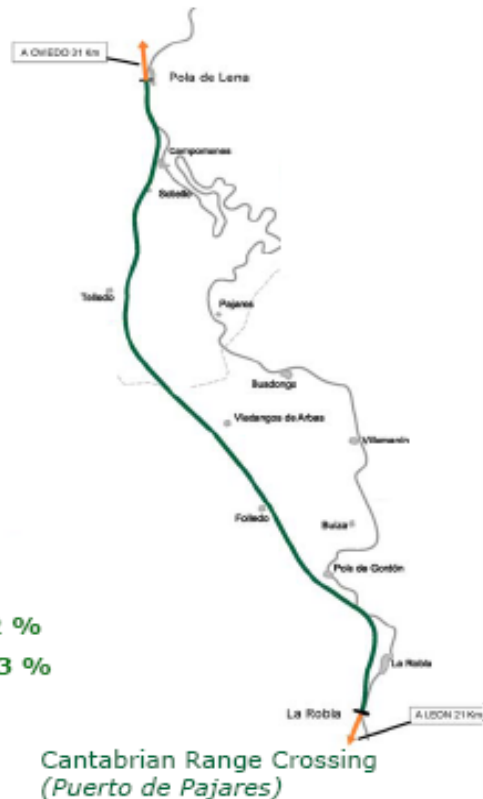
(under construction)

LENGTH: 49 km ▼ 33 %

SPEED: 250 km/h ▲ 312 %

JOURNEY TIME: 15' ▼ 73 %

BIGGEST TUNNEL:
PAJARES (25 km)



VALLADOLID

HSL Madrid-Valladolid

250 km → 180 km ▼ 28 %

2h 20m → 0h 50m ▼ 71 %



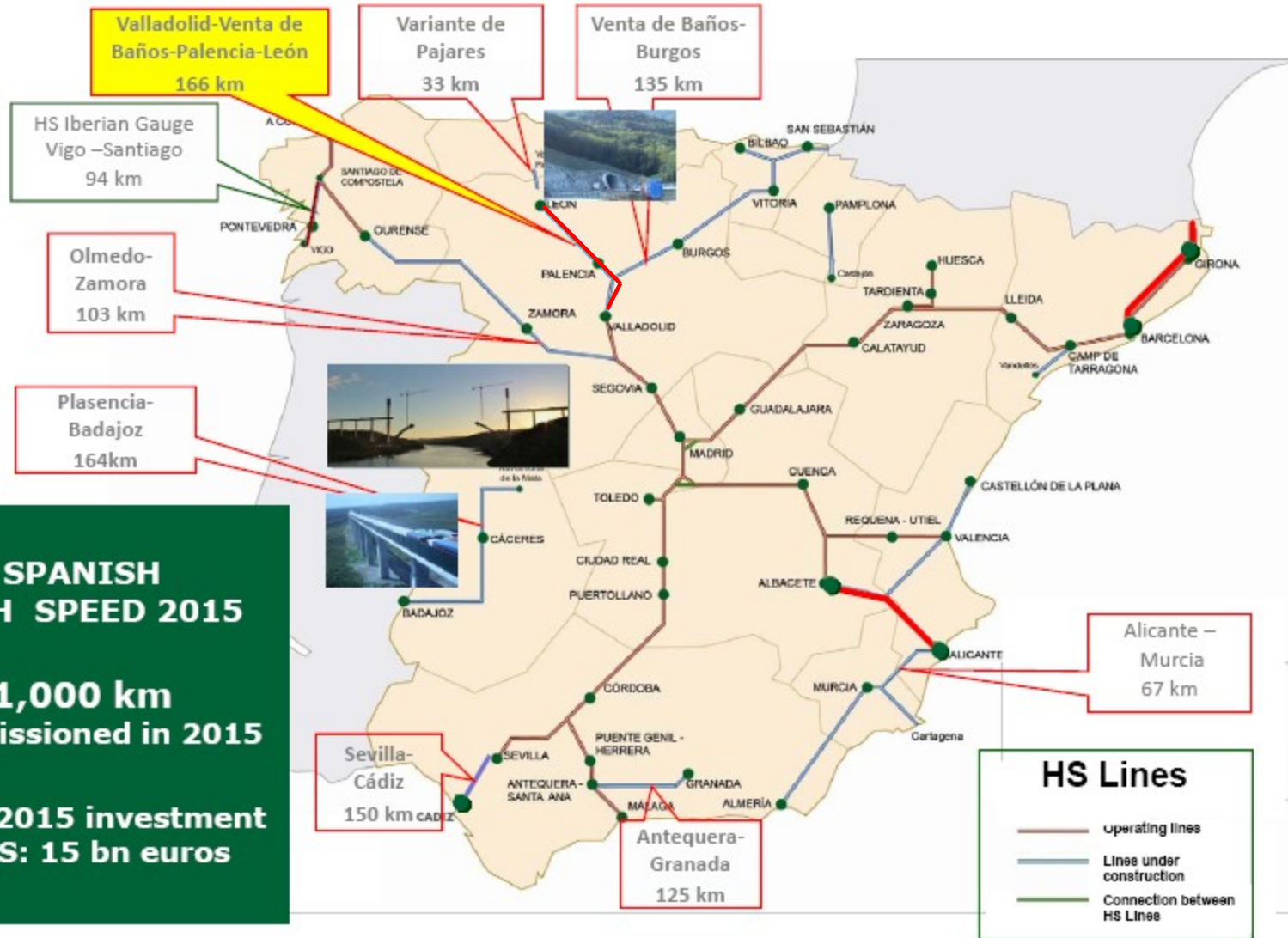
HSL Madrid-Seville

570 km → 470 km ▼ 18 %

6 h → 2h 20m ▼ 61 %



HS Lines. Overview

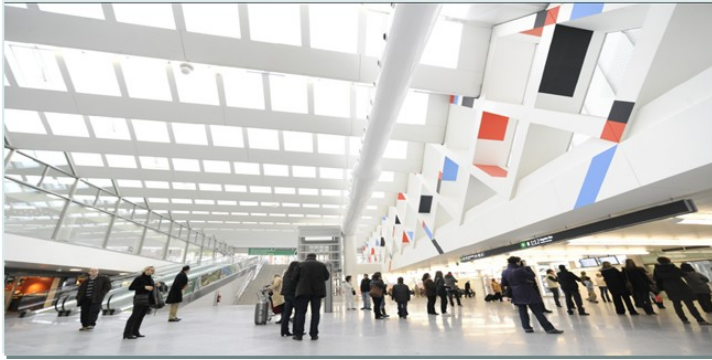


High Speed Strategy

COUNTRY	KM		
	IN OPERATION	UNDER CONSTRUCTION	PLANNED
FRANCE	2.036	740	1.786
GERMANY	1.352	466	324
SPAIN	3.145	1.382	1.496
UNITED KINGDOM	113	-	543
CHINA	18.838	11.411	830
JAPAN	2.892	551	179
SAUDI ARABIA	-	550	-
TURKEY	688	469	1.134
RUSSIA	-	-	2.978



HS Lines. Stations



Madrid Puerta Atocha



Málaga María Zambrano (VIALIA)



Cuenca Fernando Zóbel (Brunel Award 2011)



41 High Speed Train Stations

- 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

Atocha Station new railway complex



NEW RAILWAY COMPLEX AT ATOCHA STATION



Future High Speed Railway Network in Madrid

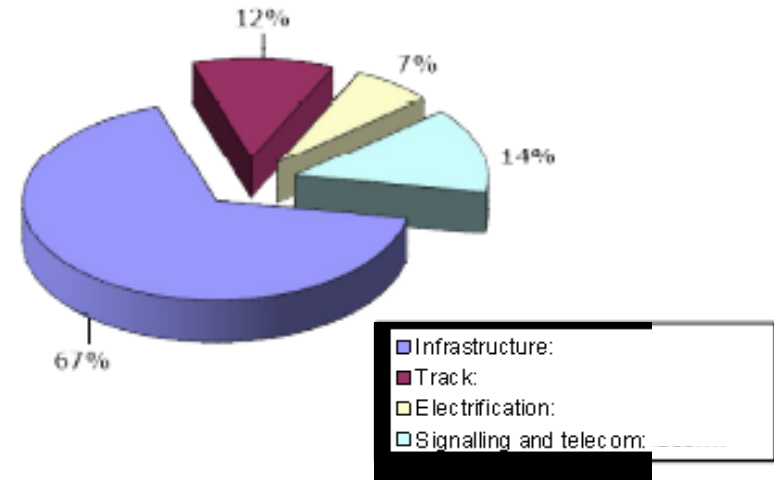


Real costs in Spanish HSL and Stations

REAL COSTS IN SPANISH HSL:

- Infrastructure: 5.4 – 14.6 M €/km
- Track: 1.7 – 2 M €/km
- Electrification: 0.8 – 1.3 M €/km
- Signalling and telecom.: 1.1 – 3.3 M €/km
- Total costs: 9.4 – 21.8 M €/km

(15,1 - 35 M \$/mi)



COST FOR LARGE AND MEDIUM-SIZED STATIONS

- Medium sized 15 -50 M € (17 – 56 M\$)
- Large 50-200 M € (56 – 225 M\$)



COSTS AND BUILDING EFFICIENCY:

Lower cost per line in Europe 16 M €/km. (29 M \$/mi)

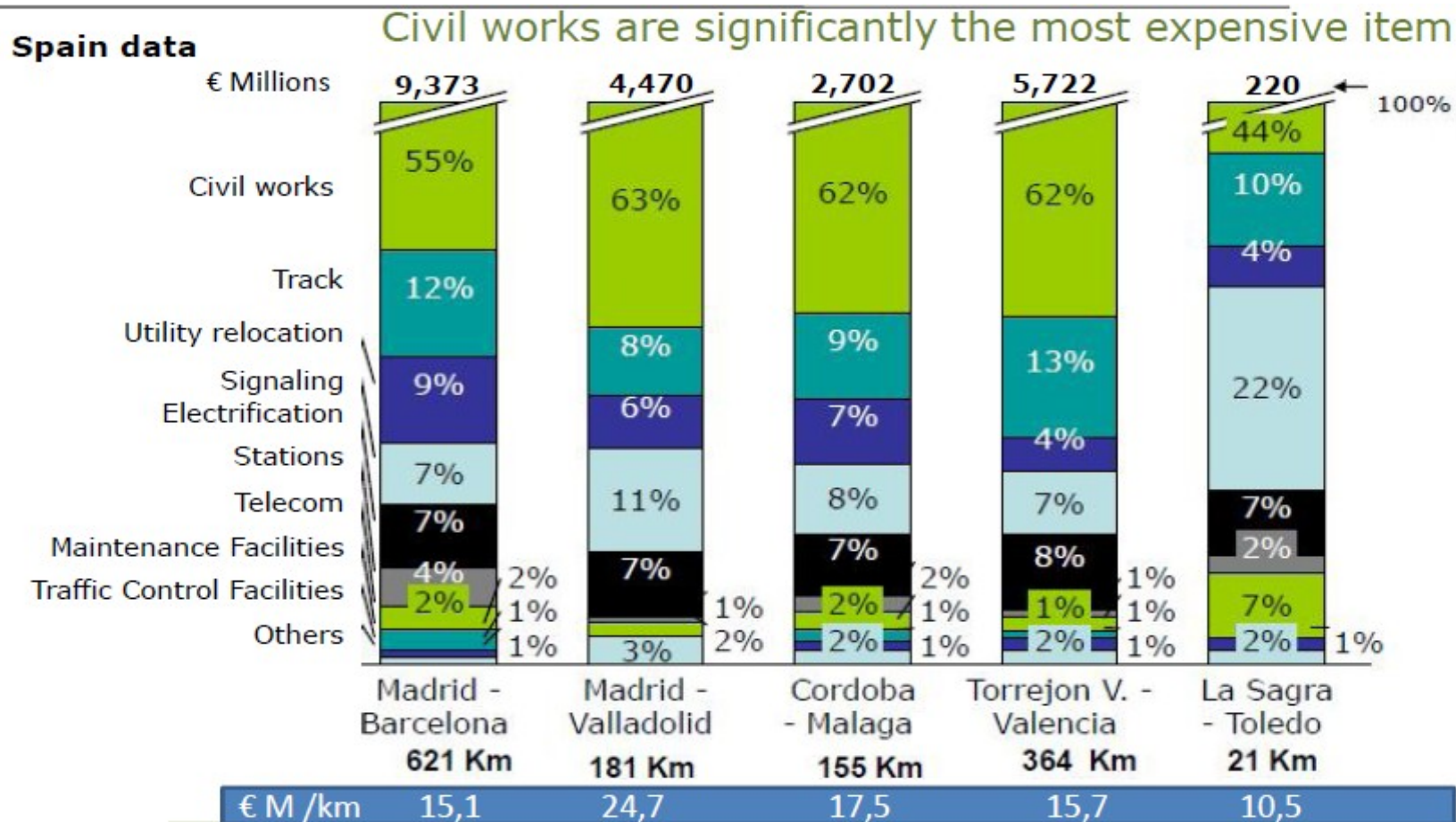
Overall time from construction to operation : 4 years

400 HS trains a day

125.000 HS seats/day

+ 25 years of experience in the complete development process of High Speed Railways

Range of investment costs (Million Euros)



→ Potential sources of extra costs

Relief and geology

Cities entrance

Interaction with the existing network

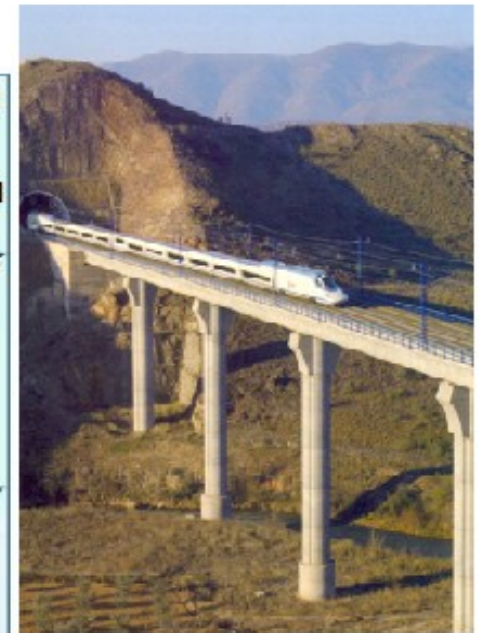
Measures for environmental mitigation

Madrid – Barcelona HSL (Opening 2003-2008)

Total length 621 km
Maximum design speed 350 km/h
Current maximum speed 310 km/h
64 tunnels- Total length 51 km (8,2%)
154 viaducts-Total length 48,9 km (7,9%)

Minimum horizontal curve radius 7.250 m
Maximum grade 2,5 %
Power supply 25kV 50 Hz AC 16 subst.
Signaling ERTMS L1 L2 & ASFA
7 passenger Terminals

Overall View



Currently operative routes and stations

652 km 2h30'
261km/h

The currently operative HSL crosses the following provinces: Madrid, Guadalajara, Soria, Zaragoza, Huesca, Lérida, Tarragona and Barcelona.

Madrid – Lérida 10th October 2003

Length: **481 Km**

Commercial railway stations:

Madrid-Puerta de Atocha
Guadalajara-Yebes
Calatayud
Zaragoza-Delicias
Lérida-Pirineos

Roda de Bará – Barcelona 20th February 2008

Length: **88.4 Km**

Commercial railway stations:

Barcelona-Sants

Lérida – Roda de Bará 19th December 2006

Length: **83 Km**

Commercial railway stations:

Camp de Tarragona



- Interoperable Line according to the European Standards
- 753 Km of double track (652.4 Km of which are already operative)
- Designed for passenger traffic and specific freights (on the Barcelona/Puerto – Figueres section)
- Designed for high capacity
- Enhanced construction parameters according to the line's high performance
- Including railway by-pass in Zaragoza and Lérida

Infrastructure parameters

✓ HORIZONTAL ALIGNMENT

- Minimum curve radius: 7.250 m (seldom 6.500 m).
- Maximum cant of the track: 140 mm (seldom 160 mm).
- Nominal cross acceleration of 0,39 m/s².

✓ VERTICAL ALIGNMENT

- Maximum gradient: 25 thousandths (2,5 %).
- Grade line alignment (kv): 45.000 m with cross acceleration of 0,21 m/s².

✓ TYPE SECTION

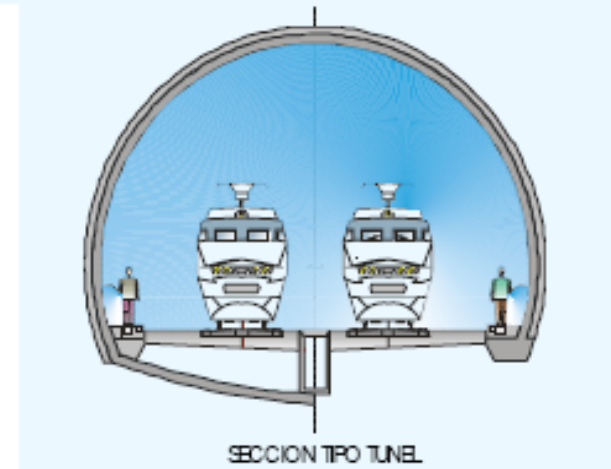
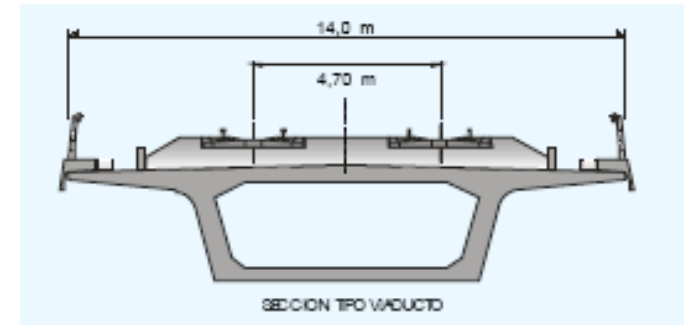
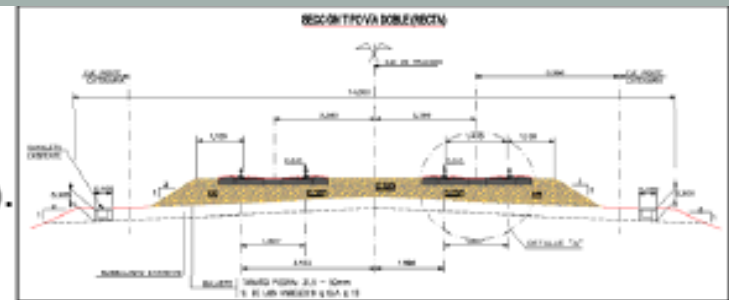
- Track-to-track centre line distance: 4.70 m.
- 14 m wide for double track type section.

✓ VIADUCTS

- Total length of operative viaducts: 48.964 m.
- The Jalón viaduct stands out for its length: 2.238 m.

✓ TUNNELS

- 51.001 m of operative tunnel between Madrid and Barcelona Sants.
- Cross-section between 75 sqm and 115 sqm.



Reference HSL Madrid-Sevilla 1992 (471 km)

371 km	V _{max} 300 km/h	R > 4.000 m
72 km	V _{max} 250 km/h	R > 3.200 m
28 km	V _{max} 215 km/h	R > 2.300 m

Track parameters

Track typology *in new Spanish HSL*

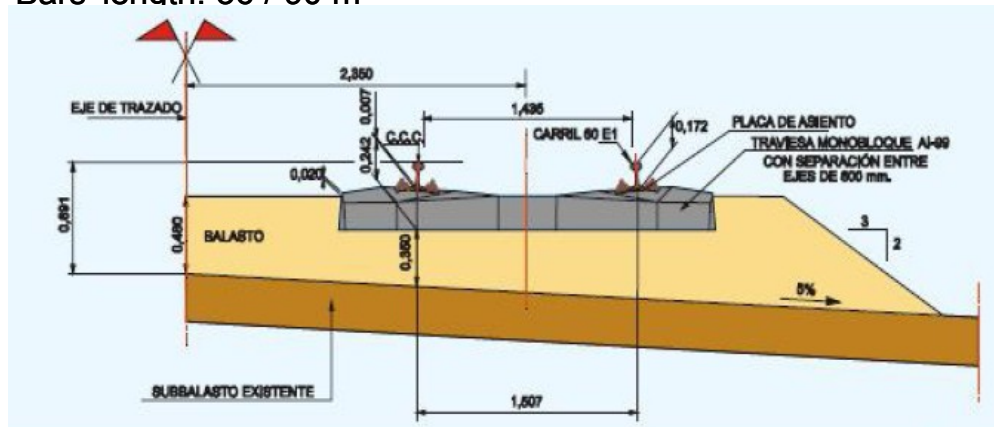
Ballasted track

Rail

- ✓ Type: 60 E 1
- ✓ Quality: 260
- ✓ Resistance: 880 N/mm²
- ✓ Hardness: 260-300 hbw
- ✓ Bars' length: 36 / 90 m

Fastening

- ✓ Tension clamp SKL-1
- ✓ A2 polyamide light angled plate
- ✓ Elastic plate 7 mm



Ballast

- ✓ 35 cm under sleeper
- ✓ Silician crushed gravel
- ✓ 32-50 mm granulometry
- ✓ L.A.: 9-15%

Sleeper

- ✓ Prestressed concrete
- ✓ Monoblock
- ✓ 2.600 x 300 x 242 mm
- ✓ Weight: 315 kg
- ✓ 1666 per km

SPECIAL TRACK COMPONENTS

Turnouts

- Turnouts
 - V 350/220 km/h
 - L > 200 m
 - Movable frog crossin
- Crossovers each 20-30 km
- Sidings each 30-40 km
 - Long straights alignments required (L > 2 km)



Apparatus denomination	Track gauge (mm)	Direct track speed km/h	Diverted track speed km/h	Tangent	Apparatus lenght m	Crossings
DSIH-AV-UIC60-17000/7300-1:50-CC-PM-TC-D/I	1,435.00	350.00	220.00	0.020	207.722	Mobile Point

Sidings

Configuration

- commercial (2685-3197m)
- technical (2164-2420m)
- restrictions

Passing tracks

- speeds
- lengths
- distances between tracks

Switches

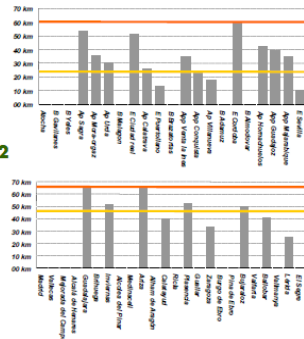
- 350/220 17000/7300 CC tg 0°02
- 350/100 3000/1500 CC tg 0°045
- 200/50 318 CR tg 0°09

Auxiliary track

- maintenance equipment
- safety



Distances



HSL Madrid-Seville
med 33.6 km
max 60.0 km

HSL Madrid-Lérída
med 47.0 km
max 65.6 km

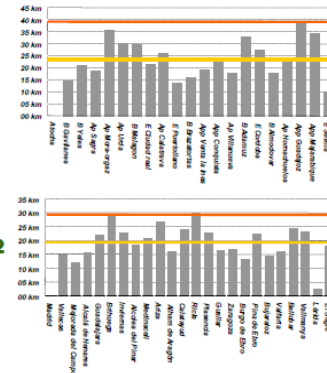
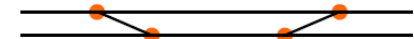
Crossovers

Configuration

- 1510 m
- Restrictions

Switches

- 350/220 17000/7300 CC tg 0°02



Distances

HSL Madrid-Seville
med 23.5 km
max 39.0 km

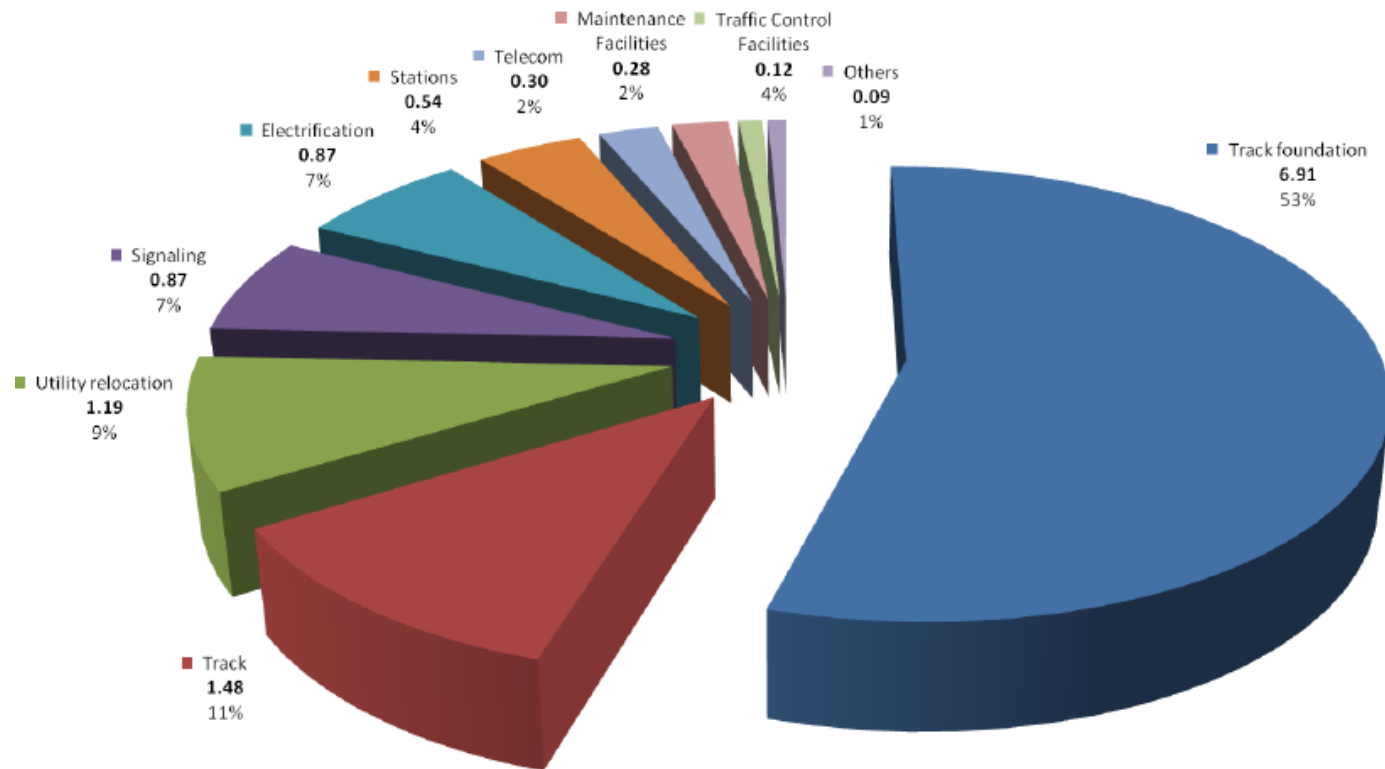
HSL Madrid-Lérída
med 19.0 km
max 29.6 km

Total costs

9,37 B EUR 2010 (10,55 B \$)

15,1 M EUR per km
(27,4 M \$ / mi)

**Madrid - Barcelona HSL
Total Costs (B\$)**



HS Lines. Construction Period

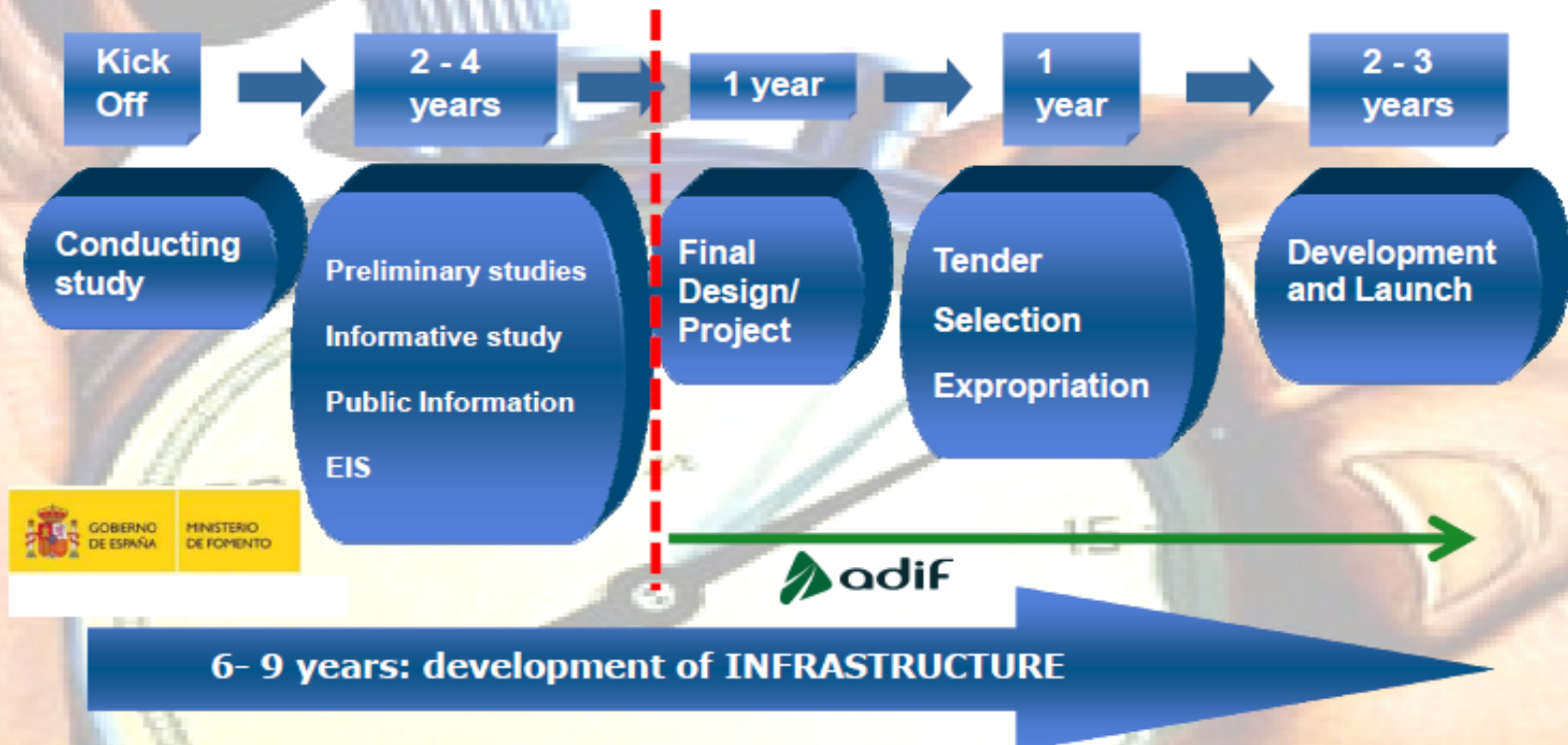
ADIF management ensures a 4 year period from the beginning of construction to operation

Steps

Minimum Timing to develop a HS new line

Phases: IDEA to INSTALLATION OF SERVICES

(DECISION MAKING STEPS ARE NOT INCLUDED)



Case in point: Madrid – Valencia HLS (I)

- ▶ 350 km new alignment
- ▶ It departs from the existing HSL Madrid-Seville, which had to be partly adapted.



Case in point: Madrid – Valencia HLS (IV)

Civil Works Design

- ▶ 32 sections for both, preliminary and detailed design
- ▶ 11 km each section (medium length)



Case in point: Madrid – Valencia HLS (V)

Track Assembly

- ▶ 5 sections
- ▶ 70 km each section (medium length)



Case in point: Madrid – Valencia HLS (VI)

Power supply

■ Overhead contact system

- ▶ 2 sections
- ▶ 175 km each section (medium length)

■ Power Substations

- ▶ 2 sections
- ▶ 175 km each section (medium length)



Case in point: Madrid – Valencia HLS (VII)

Other Railway subsystems

■ Telecommunications and signaling

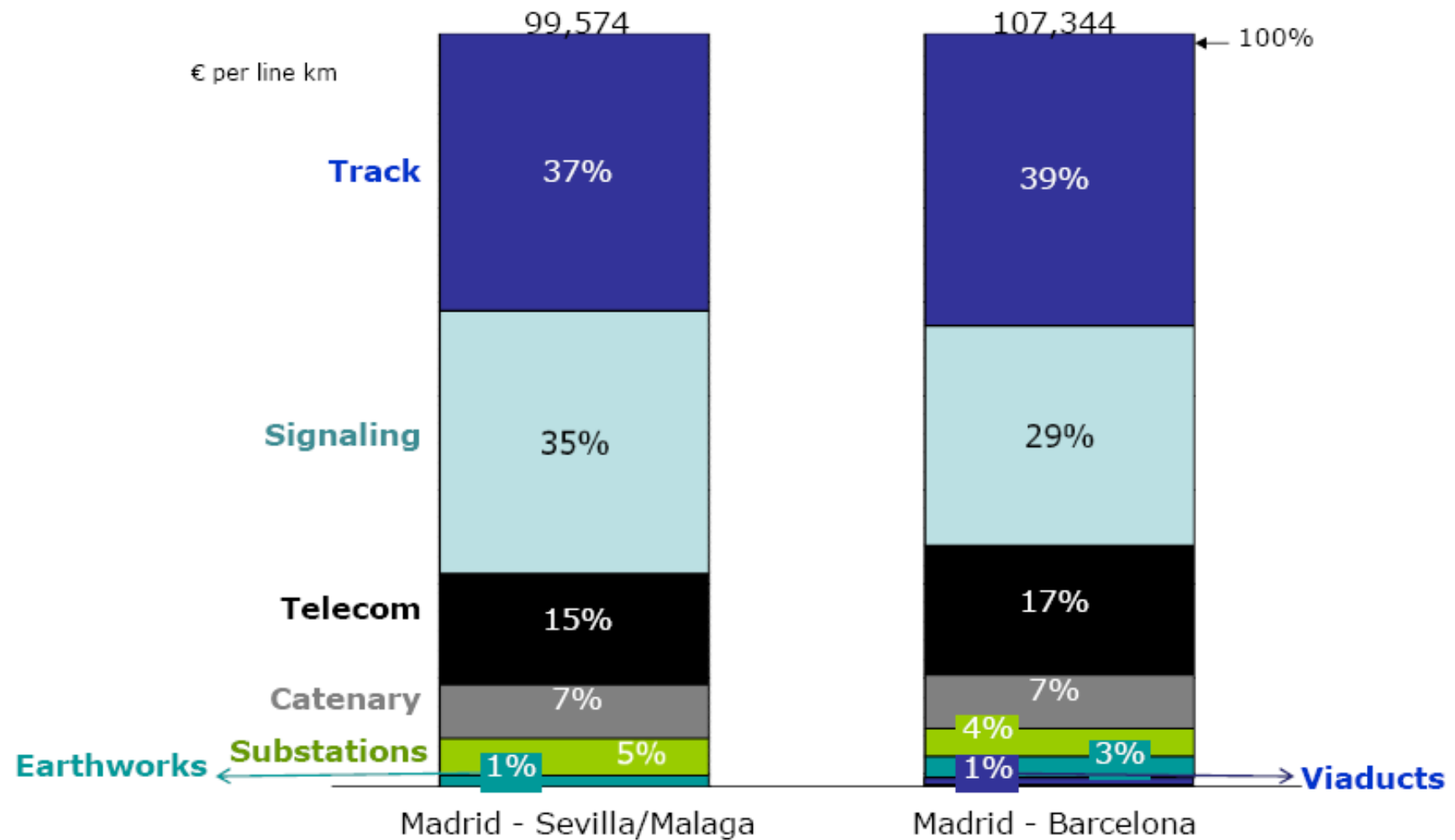
- ▶ 1 section
- ▶ 380 km long

■ GSM-R

- ▶ 1 section
- ▶ 380 km long

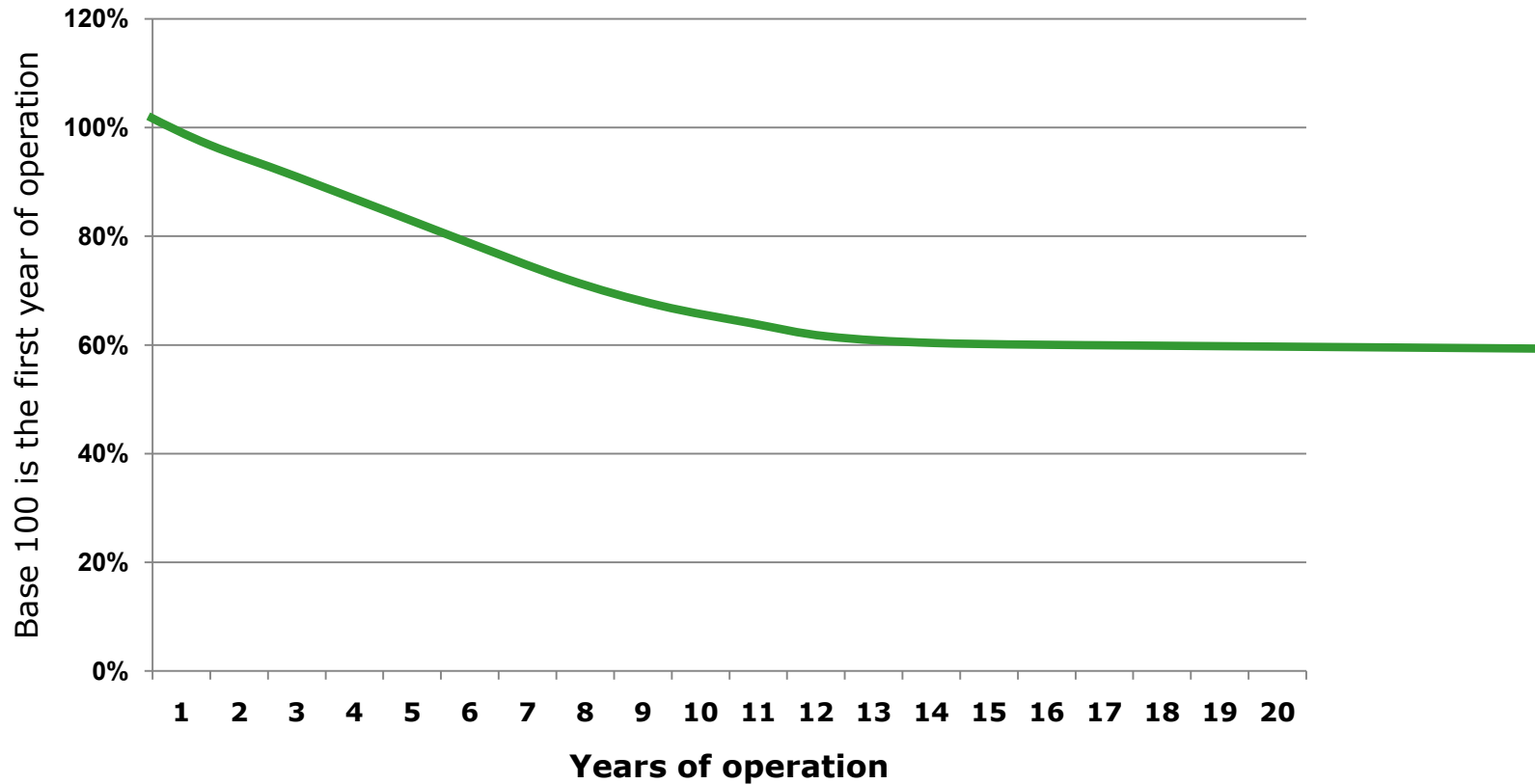


HS Lines. Efficient Maintenance



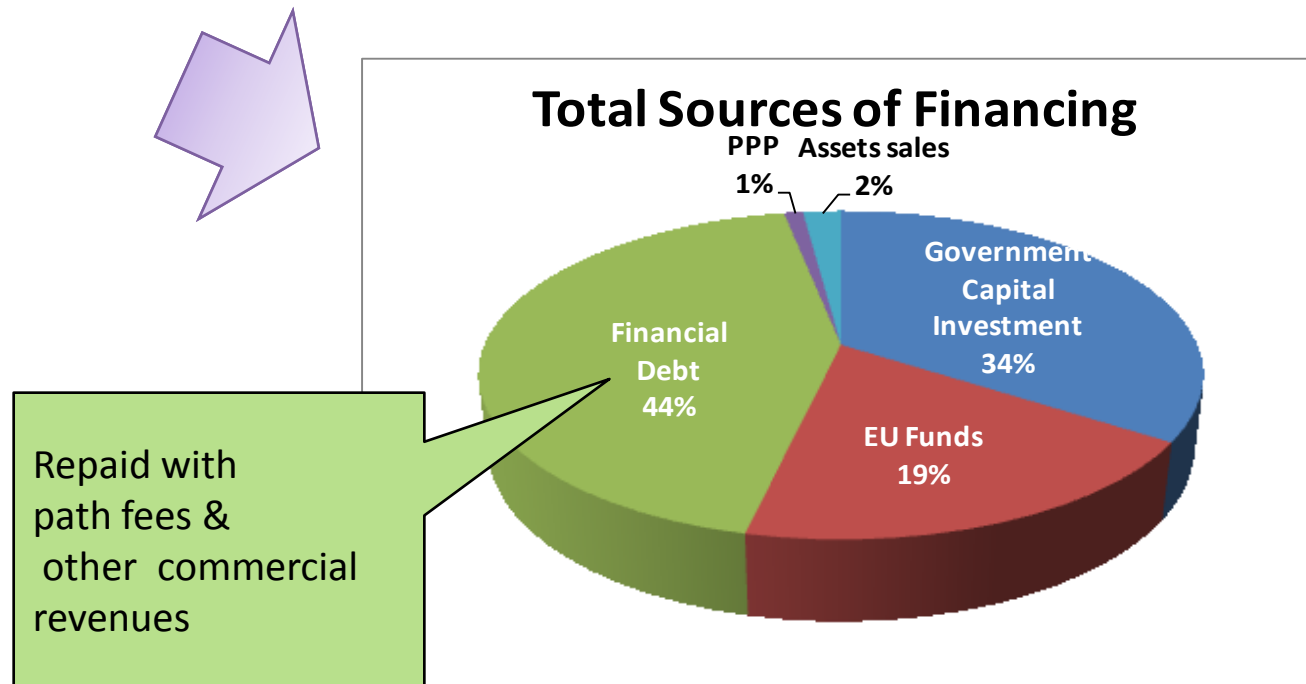
Track and Signaling are the key items to be maintained

HS maintenance costs trends



ADIF maintenance management reduces cost overtime

HS Lines. Funding



New funding sources



- New ways of public-private partnership
 - Ongoing projects in HS (Albacete-Alicante; Madrid- Galicia HSL)
 - EUR 1.5 bn. in tender processes for HS projects, medium term
 - Allows speeding-up investments
 - Supports public investment with private investment in a budgetary restructuring scene
 - Applies the experiences implemented in other modes to high speed rail.
 - Projects ready for a tendering process.
- Ongoing public-private partnerships : VIALIA projects in stations
 - 40% company owned by Adif.

Adif On Going PPP Investments in HSL II

ALBACETE-LA ENCINA-ALICANTE: 177 km

- **Object:** Railway signalling works, Railways traffic-control equipment and maintenance services.
- **Nº of Parts:** 1 Part / 1 SPV.
- **Tendering Number :** 1 Contract from 31/2007 Law.
- **SPV Equity:** 10% Construction Budget.
- **Adif share in SPV Equity:** 10%.
- **Construction Budget:** 213,4 M€ (VAT Excluded).
- **Máx PPD (Availability Payment):** 165,3 M€ (VAT Excluded).
- **Estimated financial cost of Deferred Payments:** 48,5 M€
- **Availability Term:** 20 Years from Operating Start.
- **Current Status:** Contract Awarded on October 28th, 2011. Contract Signature with SPV on December 5th 2011. On service since June, 18th 2013. Main awarding figures:
 - **Construction Budget** 132,6 M€ (VAT Excluded) Low Bidder 37,86 %
 - **Availability Payment** 105,4 M€ (VAT Excluded) Low Bidder 36,25 %
 - **Financial Cost:** 34,0 M €

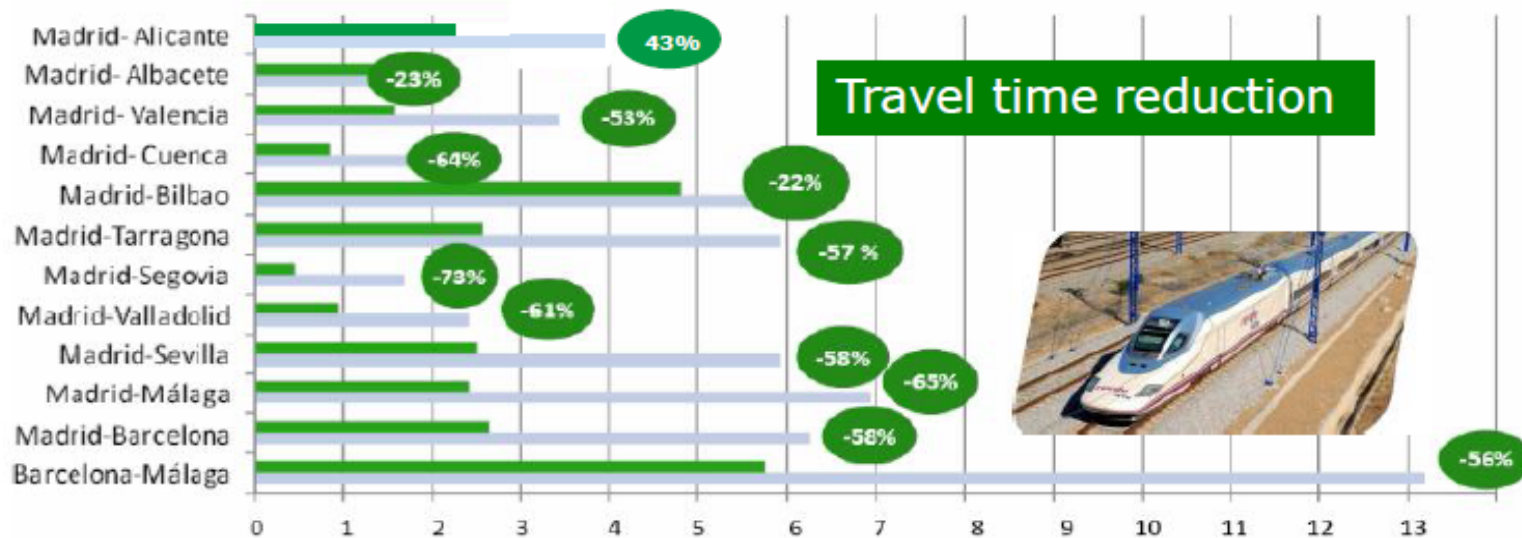
LAV Albacete Alicante



HS Lines. Benefits and Positive Impacts

High Speed rail:

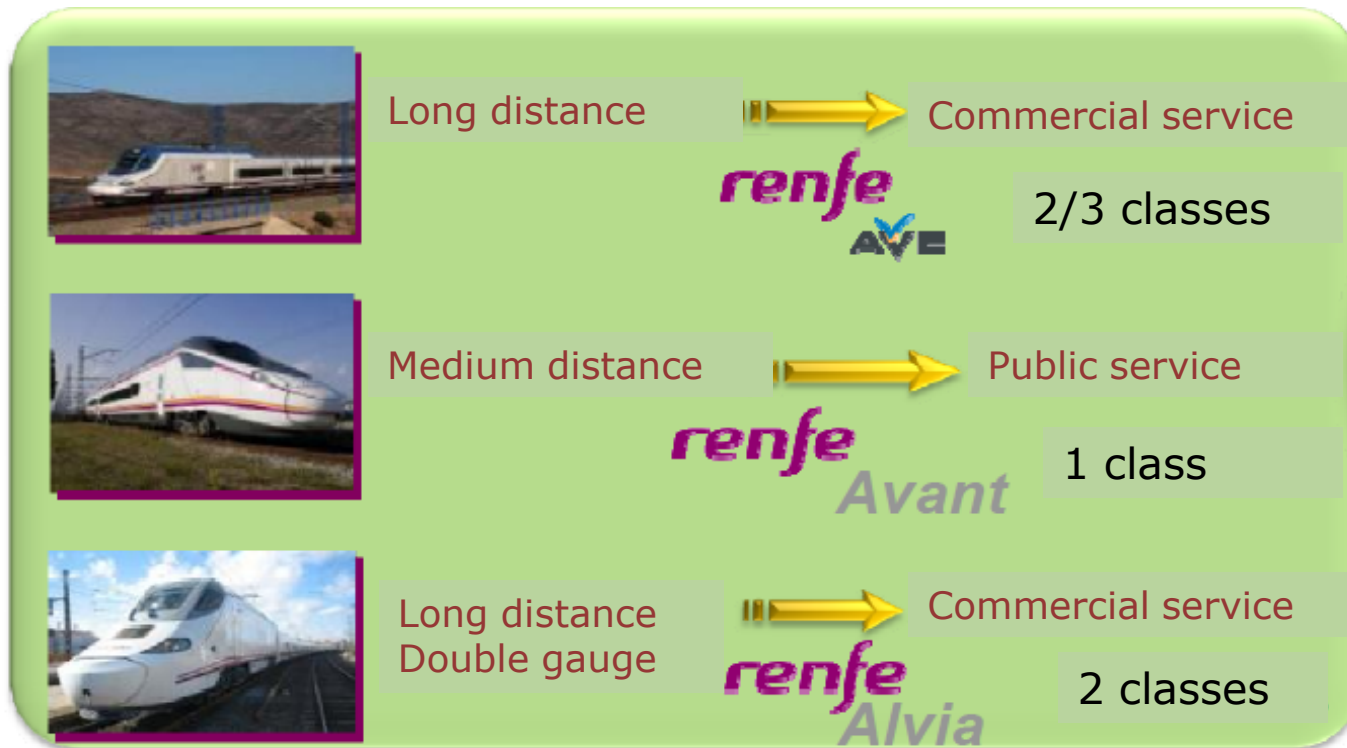
- **attracts** an important percentage (> 30%) of new passengers
- **is very competitive** with regard to air in short- medium distances
- **increases its modal share** during the first 3 years up to becoming stable
- **takes up share** from the air mode and, to a lesser extent, from the private vehicle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



30 million HS passengers/year in Spain
25 % HS passengers-km

High Speed services. The Spanish model

- ❑ Different approach in relation to other countries
- ❑ Three different services use the same infrastructure



DIFFERENT PRICES
AFFORDABLE TO THE
WHOLE POPULATION

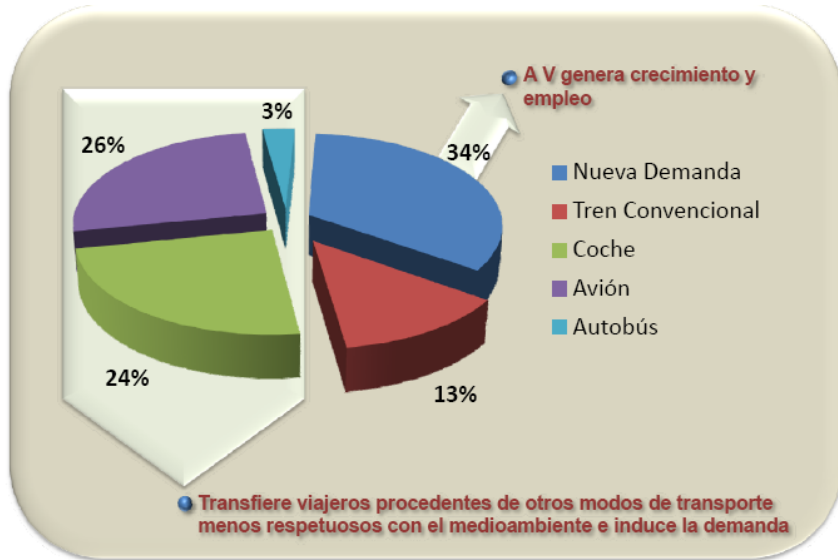
Source: Renfe

Impact on demand and mobility

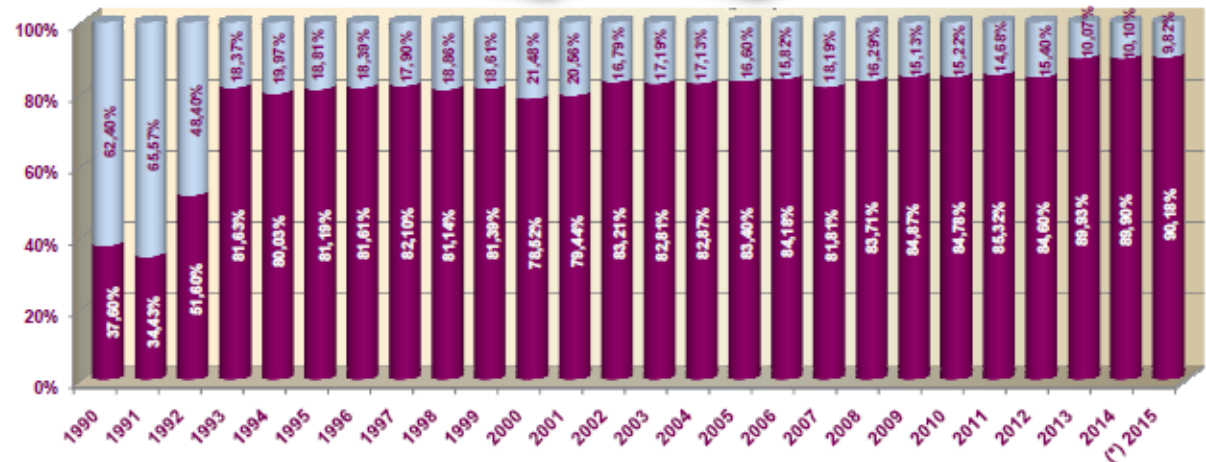
HS generates Growth and employment

HS Madrid - Sevilla: Success from the first exploitation year

34% new demand induced by Hig Speed



SOURCE:
RENFE



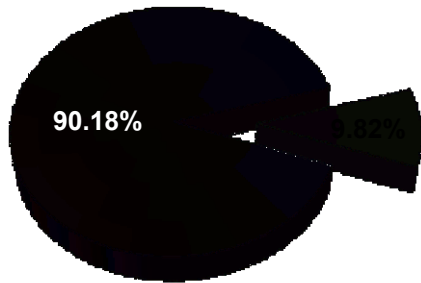
Market share
Madrid-Sevilla
HS 90,2% in 2015

Market Share Train vs. Plane



Madrid - Sevilla

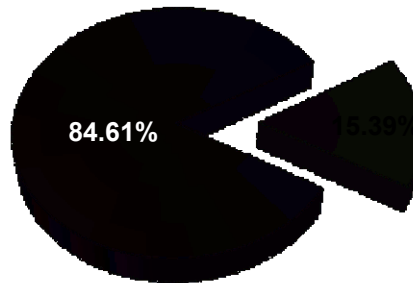
■ TRAIN ■ PLANE



72.17% of occupation in 2014

Madrid - Málaga

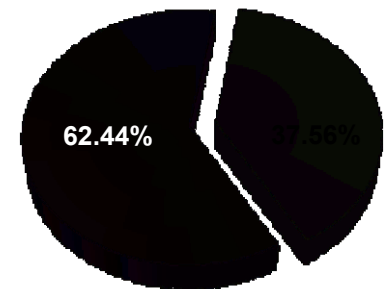
■ TRAIN ■ PLANE



70.67% of occupation in 2014

Madrid - Barcelona

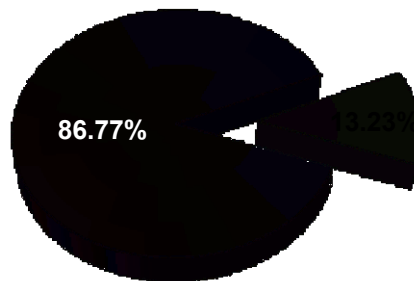
■ TRAIN ■ PLANE



86.29% of occupation in 2014

Madrid - Valencia

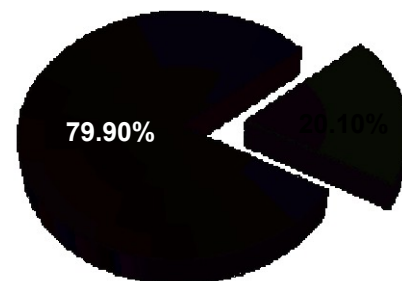
■ TRAIN ■ PLANE



61.88% of occupation in 2014

Madrid - Alicante

■ TRAIN ■ PLANE



77.43% of occupation in 2014

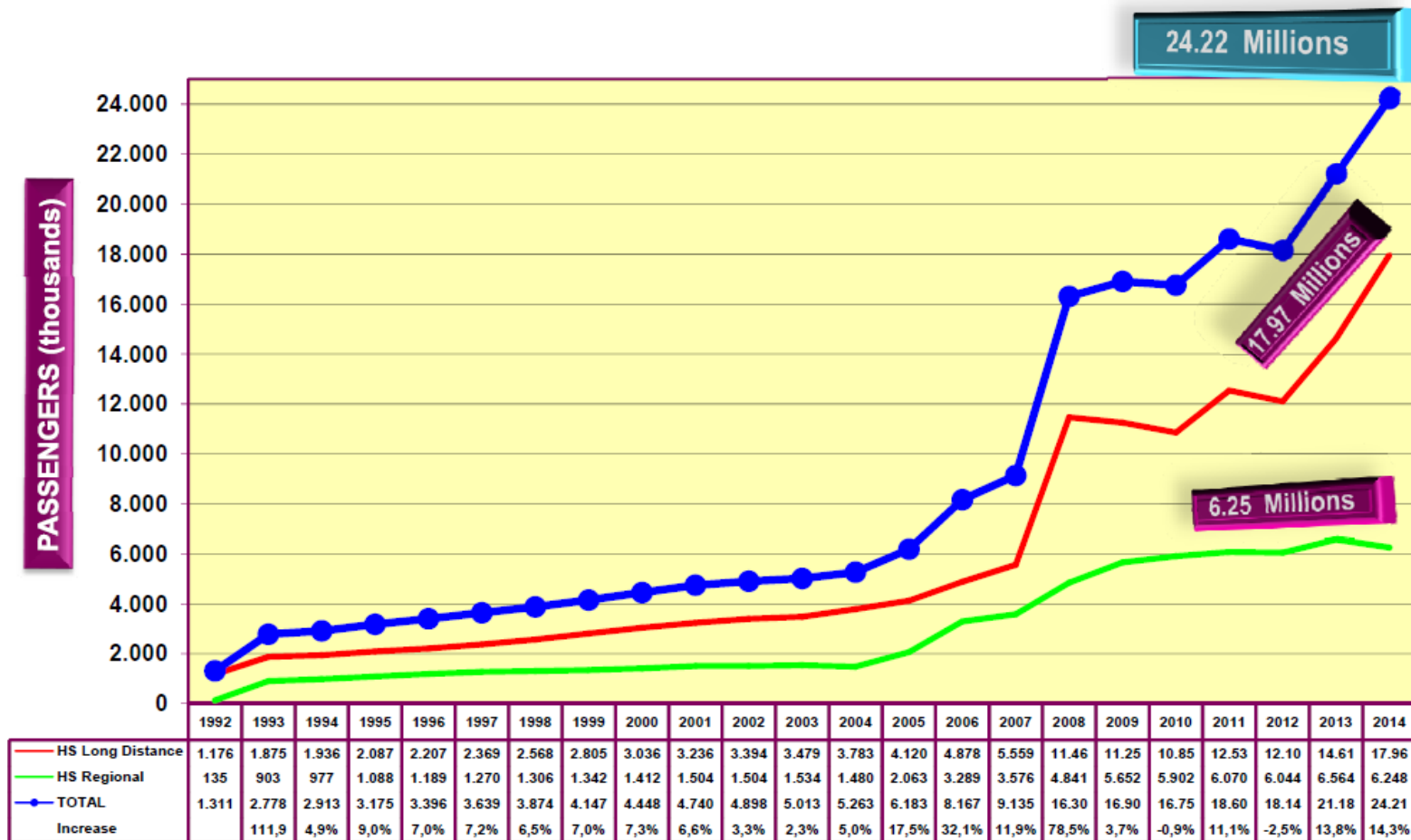
SOURCE:
RENFE

Evolution of High Speed traffic

Double Gauge trains add more than 7 Millions passengers in 2014

**Growth in 2014:
higher than 14 %**

Passenger numbers evolution (only pure high speed services)



**SOURCE:
RENFE**

MEDITERRANEAN CORRIDOR

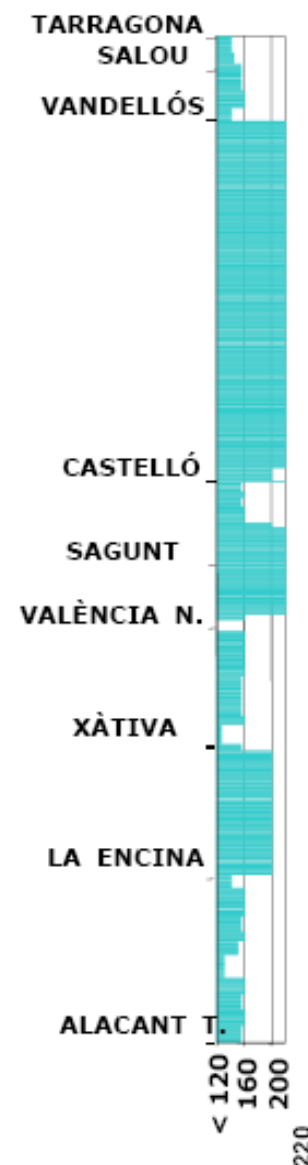
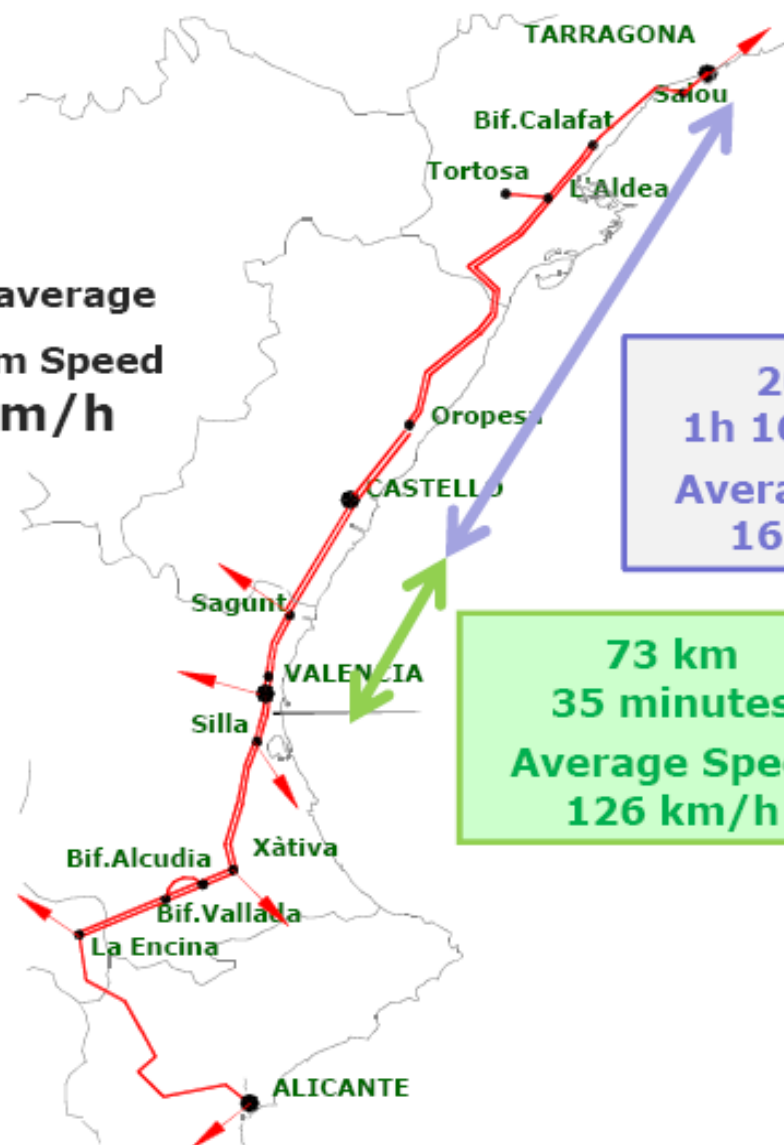
HSR + Conventional Lines

- Mixed traffic. Speed 220 km/h between Valencia and Tarragona
- Link to the main ports: Barcelona, Tarragona, Valencia, Alicante, Cartagena
- Line UIC gauge between Barcelona and Tarragona (HSL) and interim link Barcelona – French Border

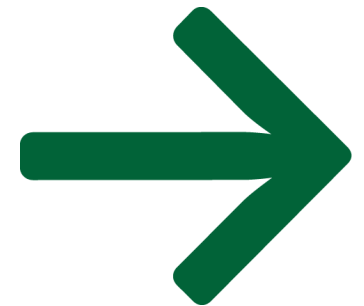


Improving conventional lines: Mediterranean Corridor

Weighted average
of Maximum Speed
197 Km/h



Spanish technology



Spanish strength in railways technology

- Tunnels:
 - Guadarrama Tunnel (28km) 5th worldwide.
 - Pajares Tunnel (25km). 6th longest in Europe
 - Drilling with TBM world record: 90 meters/day at La Cabrera Tunnel. (Madrid-Valencia HSL)
- Viaducts:
 - Ulla Viaduct* (Galicia Line), the tallest viaduct in Spain (higher pylons, 117 m; tallest central arch , 105 m)
 - Deza Viaduct* (Galicia Line), built by employing a very accurate and complex constructing procedure, by lowering 2 half arches.
 - Contreras Viaduct (Levante HSL)*: one of the longest concrete arch spans in Europe (261 m)
- Track: automatic track gauge switches for different gauge performed at 30 km/h
- Switches: 350 km/h switches, to be crossed at 220 km/h through a deviation
- 2 km/day track laying over ballast
- Catenary: Spanish HS catenary (350 km/h + 10%) interoperable TSI
- Sub-stations: own design 2 x 25 kv
- Maintenance technologies: laboratory and track examination trains
- R+D+i: energy efficiency, raising ballast, track models...



HS LINE ATLANTIC AXLE (La Coruña – Vigo, 156 km 97 miles)



Catoira Viaduct / Ulla River

1,620 m (1 mile)

Main arc 240 m (0,15 mi)

World record of metallic grid bridges



HS LINE MADRID - EXTREMADURA



(350 km 215 mi)

210 km 130 mi on works

Alcantara Viaduct / Tagus River

Lenght 1,488 m (0,925 mi)

Main arc 324 m (0,2 mi)
max piles height 90 m



Spanish Experience in ERTMS

Still nowadays, each country still has its own rail "language" for managing the movement of the trains on its network. Rail interoperability is a key goal for Europe, so that trains can cross borders without stopping. ERTMS aims at replacing the different national train control and command systems in Europe.

The deployment of ERTMS will enable the creation of a seamless European railway system and increase European railway's competitiveness.

In addition, ERTMS is arguably the most performant train control system in the world and brings significant advantages in terms of maintenance costs savings, safety, reliability, punctuality and traffic capacity.

This explains why ERTMS is increasingly successful outside Europe, and is becoming the train control system of choice for countries such as China, India, Taiwan, South Korea and Saudi Arabia.

➤ SPAIN IS PIONEER IN ERTMS:

- 1,974 km of High Speed lines equipped with ERTMS (more km than any other European country)
- ERTMS level 2 (>300 km/h. October 2011) deployed in Madrid- Barcelona line

DaVinci system

The Spanish DaVinci system was designed to manage HS lines.

- **Integration of all telecommands in the HSL allowing centralized real time operation**
 - ❖ Centralized Train Control CTC
 - ❖ ERMTS central post
 - ❖ Energy Supply
 - ❖ Communications Supervision (Fixed and mobile communications)
 - ❖ Auxiliary supervision systems
 - ❖ Video surveillance
- **In addition includes the following environments.**
 - ❖ Simulation and Training
 - ❖ Integrated reconstruction of events
 - ❖ Validation and testing environments



The DaVinci experience

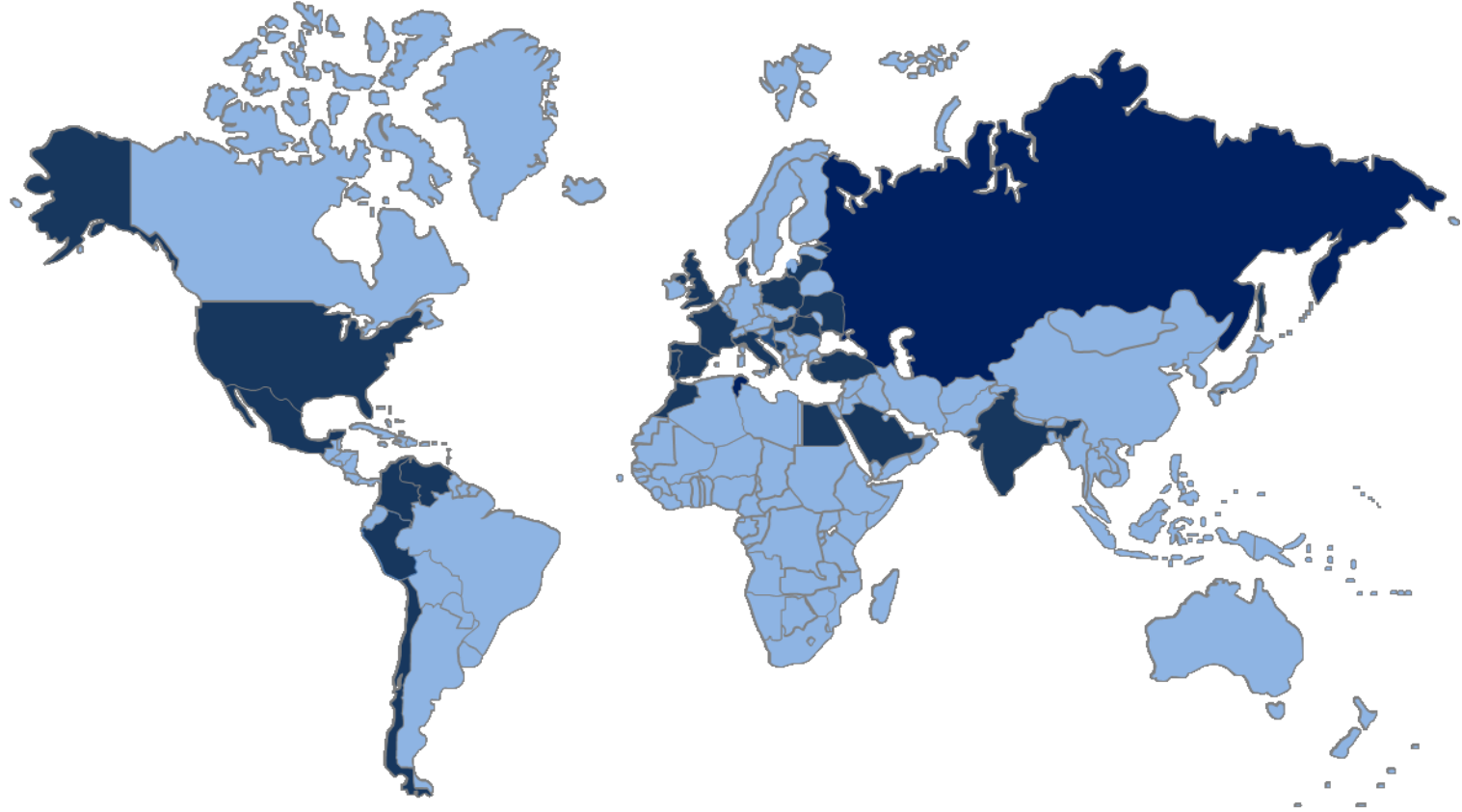
Adif lines
FEVE lines
London & Medellín Underground
Morocco lines
Lithuanian lines



Global reach



Global reach. Adif around the world



USA Mexico Chile Colombia Peru Venezuela Egypt Morocco
Tunisia Saudi Arabia India Russia Turkey Bosnia & Herzegovina
Croatia Denmark Estonia France Hungary Italy Lithuania
Poland Portugal United Kingdom Romania Ukraine

Adif's strengths. A competitive offer

Based on our proven expertise, our offer is mainly focused on providing **KNOWLEDGE TRANSFER** in various forms

- ⇒ Operational Assistance
- ⇒ Constructive Technical Assistance
- ⇒ Training

Adif can also provide a very valuable assistance in **CAPACITY-BUILDING** for the very first steps of railways planning

- legal framework
- institutional development

+ INTERIM MANAGEMENT, when particular needs or close timelines need to be met

+ TWINNING programs alongside the European Union

Global reach. Haramain Project

- ❖ Contract: EUR 6.74 bn. Participation of 12 Spanish companies
- ❖ Construction, operation, maintenance of HSL in Saudi Arabia, 12 years.
Mecca-Medina: 449 km. 5 stations (Mecca, Jeddah, KAIA, King Abdullah Economic City, Medina Central)
- ❖ Phase II awarded to a Spanish Consortium:
 - Design and installation of track, signalling, telecommunications, electrification, rail systems
 - Procurement of rolling stock
 - Operations & integral maintenance for 12 years
- ❖ Adif responsibility:
 - Technological integration
 - Design, project, construction and start operations management (track, signalling, telecommunications, electrification, rail systems).
 - Maintenance & Traffic management
 - Stations
 - Safety & Security





Thank you very much for your attention



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