International System Summary: **FRANCE**

HighSpeedRail
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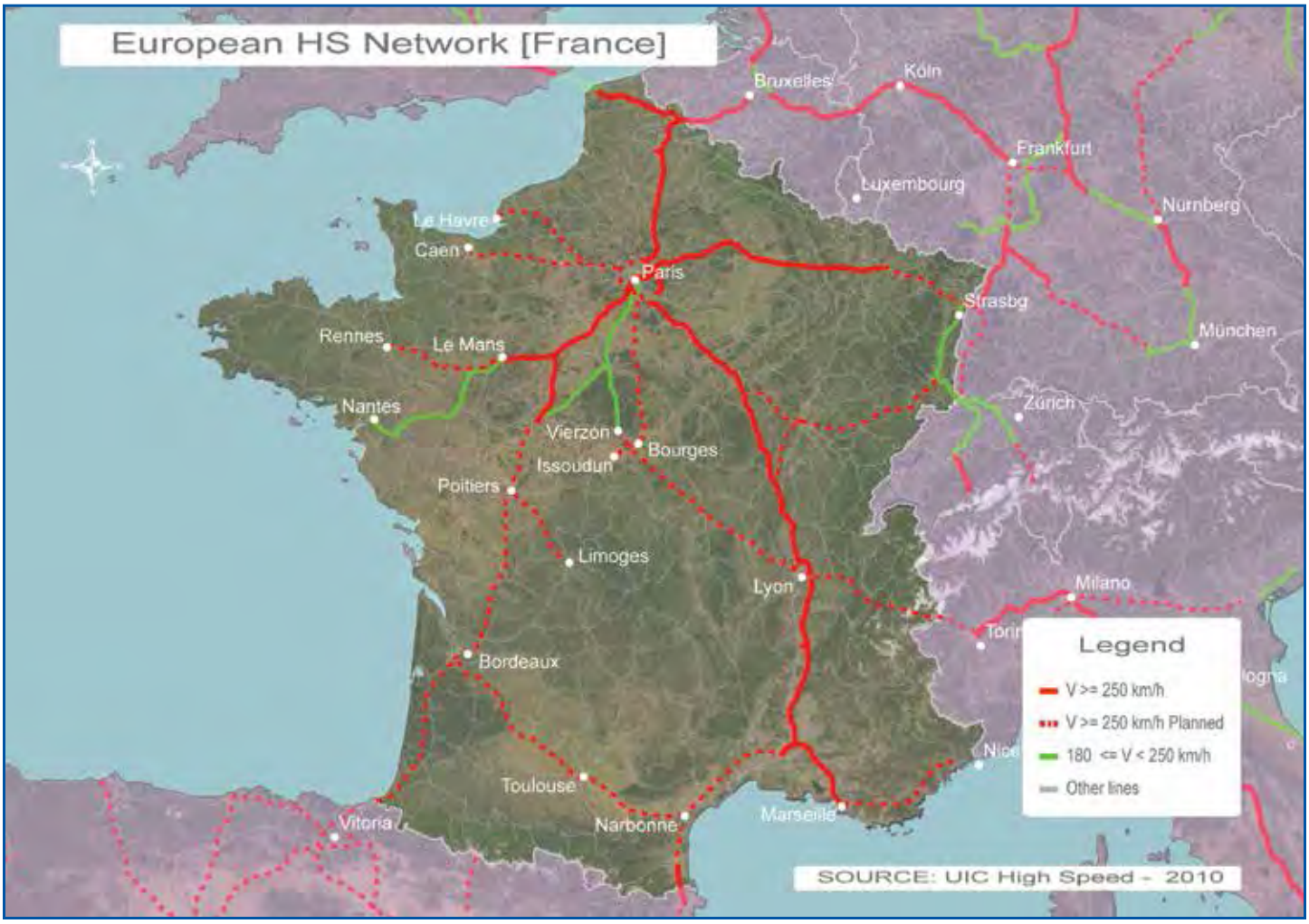

UIC Map of France's High-Speed Rail Lines

France is located in Western Europe, bordering Spain, Belgium, Luxembourg, Germany, Switzerland, and Italy, with the English Channel, Bay of Biscay, and the Mediterranean Sea forming its coastline. Slightly smaller in size than the State of Texas, France, including French controlled regions around the world, has 65.6 million people, which ranks it 21st in world population. In 2010, 85 percent of the population was designated as urban in nature. The country's capital of Paris is its largest city with 10.4 million people, followed by Marseille (1.457 million), Lyon (1.456 million), and Lille (1.028 million). France's gross domestic product (GDP) of $2.214 trillion ranks 10th in the world; and the GDP per capita of $35,000 ranks 36th. France currently has almost 1,900 km (1,180 miles) of high-speed rail lines operating, with an additional 210 km (130 miles) under construction and 2,600 km (1,600 miles) planned for future development. The figure above displays the International Union of Railways (UIC) map of France's operational and planned high-speed rail system.

TGV French High Speed Trains at the train station

SYSTEM DESCRIPTION AND HISTORY

France became the first country in Europe to provide high-speed rail service with the 1981 opening of the 419 km (260 mile) line between Paris and Lyon, known as LGV Paris Sud Est. France was motivated to make this improvement in order to increase capacity on congested sections of their existing passenger rail network and implementation of this service reduced travel times from 4 hours to 2 hours between Paris and Lyon. The French National Railway (SNCF) has continued to expand the Train a Grande Vitesse (TGV) network that now is approximately 1,900 km (1,180 miles) in length. The table below contains the current speed and length of high-speed line segments in service, the line segments under construction, and the planned segments for future development identified as their regional segment name according to the UIC. Upon complete build-out of these segments, the TGV network would exceed 4,700 km (2,900 miles) and connect to several bordering country's high-speed rail networks. The network is largely a hub and spoke configuration radiating outward from the hub of Paris. Peterman (2009) indicates this is due to the relatively low population density of France and the central role of Paris as the nation's capital and largest population center.

The design of the network provides high-speed operations between the stations, but allows for operation on conventional lines in the major urban areas. This type of operation allows for access to densely populated city centers without a tremendous financial investment and also allows for seamless operations to other areas beyond the French borders.

UIC Table of France's High-Speed Rail Lines

Stage	Speed		Year Opened	Length	
	km/h	mph		km	miles
In Operation:					
LGV Paris Sud Est	300	185	1981-83	419	260
LGV Atlantique	300	185	1989-90	291	181
LGV Contournement Lyon	300	185	1992-94	121	75
LGV Nord – Europe	300	185	1994-96	346	215
LGV Interconnexion IDF	300	185	1994-96	104	65
LGV Méditerranée	320	200	2001	259	161
LGV Est	320	200	2007	332	206
(Figueres -) Frontière – Perpignan	300	185	2010	24	15
TOTAL				**1,896**	**1,178**
Under Construction:					
LGV Dijon – Mulhouse	320	200	2011	140	87
Contournement Nîmes – Montpellier	300	185	2012	70	43
TOTAL				**210**	**130**
Planned:					
LGV Sud Europe Atlantique S	-	-	2013	120	75
LGV Bretagne – Pays de la Loire	-	-	2013	188	117
LGV Est – Européenne (Second phase)	-	-	2014-15	100	62
LGV Poitiers – Limoges	-	-	2015	115	71
LGV Sud Europe Atlantique N	-	-	2016	180	112
LGV Bordeaux – Toulouse	-	-	2016	230	143
LGV Rhin – Rhône Br Est (Second phase)	-	-	2015-20	48	30
LGV PACA	-	-	2020	200	124
Interconnexion Sud IDF	-	-	2020	40	25
LGV Bordeaux – Espagne	-	-	2020	230	143
LGV Lyon – Turin	-	-	2020	150	93
LGV Montpellier – Perpignan	-	-	2022	150	93
LGV Picardie	-	-	2022	250	155
LGV Rhin – Rhône Branche S	-	-	2022	100	62
LGV Rhin – Rhône Branche Ouest	-	-	2022	85	53
LGV Paris – Lyon bis	-	-	2025	430	267
TOTAL				**2,616**	**1,626**
GRAND TOTAL				**4,722**	**2,934**

Sources: High-Speed Lines in the World; High Speed Rail (HSR) in the United States; High Speed Rail Passenger Services: World Experience and U.S. Applications.

TGV4417 French High Speed Train during passage of the train station Forchheim toward Rastatt

ECONOMICS AND FINANCE

European Union directives to separate rail infrastructure ownership and operations resulted in the creation of Reseau Ferree de France (RFF) as the infrastructure manager in charge of construction and maintenance, with SNCF remaining as the operator of the TGV services within the country. Both entities remain solely French government agencies. Thompson (2011) reports that RFF has a complex system of access charges based both on reserved capacity and on use that are adjusted for time of day and by category of line, with high-speed passenger rail lines paying considerably more than conventional lines. These charges are intended to recover about 60 percent of total financial infrastructure costs, while the remainder is from government contributions.

The infrastructure is publicly owned with SNCF as the operator, however, recent European Union policy dictates that operations become open to competition from other national and private operators, such as DB (Germany's rail operator) and Air France. The international long distance high-speed line segments, such as between France and England or France and Belgium, are already operated by different consortia, Eurostar and Thalys in the cases mentioned.

Financing for high-speed lines, according to Thompson (2011), has largely been a government expenditure but has, in later segments, incorporated contributions from the European Union sources and private sector concessions and partnerships. The first project financed using the Public-Private Partnership model was the LGV Perpignan-Figueres line connecting France to Spain, which opened in 2010. Dutzik et al. (2010) report that France's first high-speed line between Paris and Lyon proved to be profitable shortly after inception with the construction cost paid back within 12 years. In total, approximately 80 percent of the French high-speed rail services break even or make money. Profits gained are used to subsidize regional passenger rail services. The authors indicate that in 2008, as a result of record ridership during a worldwide spike in oil prices, that SNCF paid a dividend of $190 million to French taxpayers.

Sources: A Track Record of Success: High-Speed Rail Around the World and Its Promise for America; High Speed Rail Passenger Services: World Experience and U.S. Applications; California High-Speed Rail Project: International Case Studies; High-Speed Rail: A Study of International Best Practices and Identification of Opportunities in the U.S.

RIDERSHIP AND TRANSPORTATION SYSTEM IMPACTS

The French TGV system has seen steady growth since its inception, now carrying almost 115 million passengers annually as shown in the table below.

Chronology of France's High-Speed Rail Passenger Traffic

Year	Passengers (thousands)	Passenger-Km (millions)	Passenger-miles (millions)
1981	1,260	700	435
1982	6,080	3,600	2,237
1983	9,200	5,700	3,542
1984	13,770	8,300	5,157
1985	15,380	9,300	5,779
1986	15,370	9,400	5,841
1987	16,970	10,400	6,462
1988	18,100	11,200	6,959
1989	19,160	12,200	7,581
1990	29,930	14,900	9,258
1991	37,000	17,900	11,123
1992	39,300	19,000	11,806
1993	40,120	18,900	11,744
1994	43,190	20,500	12,738
1995	46,590	21,430	13,316
1996	55,915	24,787	15,402
1997	62,881	27,583	17,139
1998	70,575	30,619	19,026
1999	74,258	32,192	20,003
2000	79,685	34,747	21,591
2001	83,481	37,404	23,242
2002	87,860	39,856	24,765
2003	86,742	39,604	24,609
2004	90,890	41,439	25,749
2005	94,020	43,130	26,800
2006	97,862	44,853	27,870
2007	105,366	47,966	29,805
2008	116,054	52,564	32,662
2009	114,395	51,864	32,227

One source documents the capture of high-speed rail over air and car traffic for two of the early corridors. The Paris to Lyon segment reduced travel time from 4 hours to 2 hours. Between 1980 and 1984 air travel fell by 50 percent and car traffic along the parallel motorway grew at about one-third the rate of other nearby motorways. For the Paris to Bordeaux segment that opened in 1989, the travel time reduced from 4 hours to 3 hours, with air travel reducing by 50 percent.

The table below shows some of the popular TGV routes and the fares associated with those trips. The fares average between $0.25 and $0.42 per mile in 2009 dollars according to the source report.

Travel Information for Popular TGV Destinations

Route	Distance (miles)	Travel Time (hours)	Fare (US$)	Average Fare Per Mile (US$)	HSR / Air Market Share
Paris-Lyon	287	1:55	120.98	0.42	91% HSR/9% Air
Paris-Nantes	238	2:00	83.20	0.35	89% HSR/11% Air
Paris-Bordeaux	346	3:00	100.70	0.29	62% HSR/38% Air
Lyon-Lille	423	3:30	145.32	0.34	60% HSR/40% Air
Paris-Marseille	482	3:10	118.92	0.25	60% HSR/40% Air

Paris North Station, (Gare du Nord Station), Paris, France

The Paris Train Stations

The International Union of Railways' report High Speed and the City documents how high-speed rail stations relate to city planning and development. The Paris metropolitan

area has a population of approximately 11.8 million people, with the City of Paris having an estimated 2.2 million. The population density within the city is calculated as 1,971 people per square kilometer (5,138 people per square mile), making it one of the least densely populated cities examined in the UIC report. Other examples include Tokyo with a density of 14,254 people per square kilometer (37,158 people per square mile) and Berlin with a density of 3,848 people per square kilometer (10,031 people per square mile).

Four main high-speed rail stations serve four different services, with an additional seven high-speed rail stations within the metropolitan area. These major lines and stations include:

- TGV Nord, from Paris Gare du Nord.
- TGV Est, from Paris Gare de l'Est.
- TGV Sud-Est, from Paris Gare de Lyon.
- TGV Atlantique, from Paris Gare Montparnasse.

One major feature of interest to the high-speed network within Paris is that, as mentioned previously, the high-speed services operate over the conventional rail lines within the urban areas. So, therefore, the addition of high-speed services incorporated a new service into existing passenger rail infrastructure and facilities. As a result, service standards for all passenger rail operations greatly increased upon the inception of the TGV operations.

Sources: High Speed Rail Passenger Services: World Experience and U.S. Applications; High-Speed Rail: A Study of International Best Practices and Identification of Opportunities in the U.S.; High Speed and the City.

SUSTAINABILITY

The environmental benefits and sustainability of high-speed rail compared to other modes is often cited in reports as a reason for implementing this type of service. Two reports done by the International Union of Railways (UIC) provide calculated values of these benefits, in terms of emission reduction and environmental efficiency for the LGV Mediterranee line segment in France. The first table below shows the calculated emissions avoided with the implementation of the segment. The environmental benefits of the LGV Mediterrainee line are calculated to be almost 238,000 metric tons of CO2 per year, largely a result of the use of nuclear power..

The second table below shows the results of an additional analysis which compares the energy efficiency between the TGV, airplane, and automobile. The calculated efficiency shows that the TGV produces approximately 2 kg of CO2 per passenger, while an aircraft produces 97 kg of CO2 per passenger and a car produces 89 kg of CO2 per passenger for an end-to-end trip along the LGV Mediterranee route.

Avoided Emissions through the Construction of the 600 km long LGV Mediterranee Segment

Mode	Passengers	Transport Performance (pkm)	Emission Factor (g of CO2 per pkm)	Avoided Emissions (metric tons of CO2 per year)
Additional TGV traffic in 2004 compared to 2000	4,461,000	2,676,600,000	0.011	29,461
From air (before)	-1,780,000	-1,068,000,000	0.1632	-174,298
From road (before)	-1,190,000	-714,000,000	0.130	-92,820
Grand Sum				**-237,657**

Environmental Efficiency Comparison of the Modes along the LGV Mediterranee

		Aircraft	Car	TGV
Basic Facts	Commercial distance (km)	634	769	750
	Vehicle consumption	4038 L/flight	49 koe	17.3 Mwh
	Average number of passengers per vehicle	122	2	400
	Number of seat per vehicle	150	4	518
	Load factor (%)	80	50	77.5
Consumption and CO2 emissions	Consumption (toe)	3.9	0.1	3.8
	CO2 emission (kg)	11,823	179	692
	Energy efficiency (goe/pass km)	51	37	13
	Consumption (koe/passenger)	32.2	28.8	9.8
	Environmental efficiency (kg CO2/passenger)	97	89	2

Sources: Carbon Footprint of High Speed Rail; High Speed Rail and Sustainability.

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