Feature

French TGV Network Development

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This article discusses the high-speed railway in France with focus on past development of the TGV network, the present construction of the TGV Est, and future prospects based on the French master plan for high-speed railways adopted in December 2003.

Past TGV Developments

The 1981 opening of the French TGV Sud-Est linking Paris and Lyon was a milestone in both the history of transportation and the history of railways with similar importance to the 1964 unveiling of the shinkansen in Japan. Since that first 'bullet train,' high-speed rail has continued to enjoy great technical and commercial success in all countries that have adopted the technology. Not only is high-speed rail fast, it has also proved to be a safe, comfortable and efficient transport mode for the general population. In short, it has revitalized railway transport and has become a symbol of modern society.

High-speed rail is a well-proven system that has become a landmark in world transport and railway history. The TGV Sud-Est was Europe's first high-speed line and there is no doubt about the TGV's technical excellence after the world wheel-on-rail speed record of 515.3 km/h was set in 1990 on the south-western section of the TGV Atlantique. The 20 years from 1981 to 2001 have seen the progressive opening of the TGV Atlantique (1990), the TGV Nord Europe (1993), and the TGV Méditerranée (2001), substantiating the reliability of the TGV technologies in actual operations.

Table 1 High-speed Lines Construction Costs per km

France & Spain	US$10 million
Belgium & Germany	US$15 million
Italy	US$25 million
Netherlands	US$53 million
UK	US$74 million
Taiwan	US$37 million
Korea	US$35 million

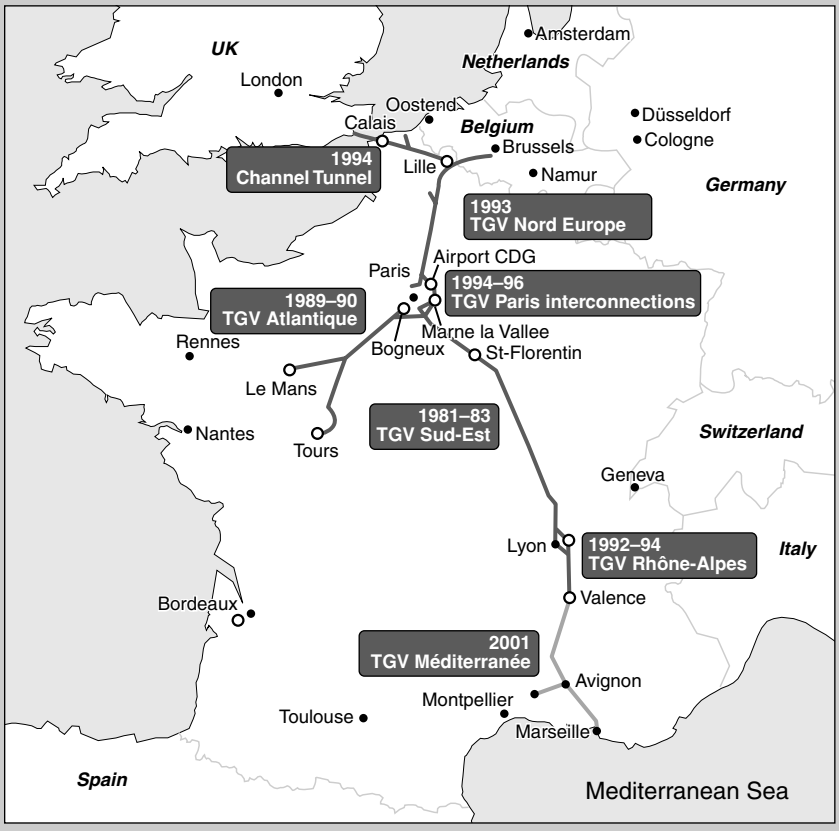
Operating French TGV Network

Technical choices

French National Railways (SNCF) started airing the first defining concepts of high-speed railway in France in 1970 with a proposal to construct a new line between Paris and Lyon based on three principles: dedicated line for passenger traffic, compatibility with existing railway network, and high-frequency operations with short journey times. These choices proved to be right and made it possible to reduce the cost of constructing new lines, achieve high operating speeds of 240–270 km/h, optimize capacity of new TGV lines, reduce operating and maintenance costs of the new lines and rolling stock, and free-up freight capacities on existing conventional lines. All these factors contributed to traffic growth and to the increased profitability of the high-speed railways.

An especially unique feature of the French TGV is its relatively low construction costs. The first TGV Sud-Est cost just $4 million per km, the lowest figure worldwide (Table 1). More recent

Figure 1 TGV High-speed Lines



projects cost about $10 million per km and the newest TGV Méditerranée with seven long viaducts (17.155 km) and one long tunnel (12.768 km) still cost only $15 million per km.

French TGV lines

The French TGV network today totals 1520 operation-km (Fig. 1) as follows:

- TGV Sud-Est (417 km): opened in 1981 (St-Florentin–Lyon Sathonay); 142-km extension in 1983 (Combs la Ville (Paris)–St-Florentin)
- TGV Atlantique (281 km): opened in 1989 (Bagneux (Paris)–Connerré Junction (Le Mans)); 101-km extension in 1990 (Courtalain Junction–Monts Junction (Tours))
- TGV Nord Europe (333 km): opened in 1993 for Paris–Lille and Lille–Calais
- TGV Paris interconnections (104 km): opened in 1994; 17-km extension link in 1996 connecting TVG Nord Europe, Sud-Est, and Atlantique
- TGV Rhône-Alpes (121 km): opened in 1992 (Montanay Junction–Satolas Airport); 84-km extension in 1994 (Satolas Airport–St Marcel les Valence)
- TGV Méditerranée (251 km): opened in 2001 (Valence–Marseille/Nîmes)

Currently, the 1070 km of unbroken TGV track running from the Channel Tunnel at Calais in the extreme north of France to Marseille in the extreme south of France on the Mediterranean Sea can be traversed by a TGV train in a little more than 3 hours at 300 km/h. It is also worth noting that all the French TGV lines are interconnected.

TGV Through operations on conventional network

Since the TGV system was designed from the start to be compatible with the existing conventional rail network, TGV trains can run on a much wider network than the dedicated high-speed lines (Fig. 2). The TGV Paris interconnections also enable

Figure 2 TGV Service Network

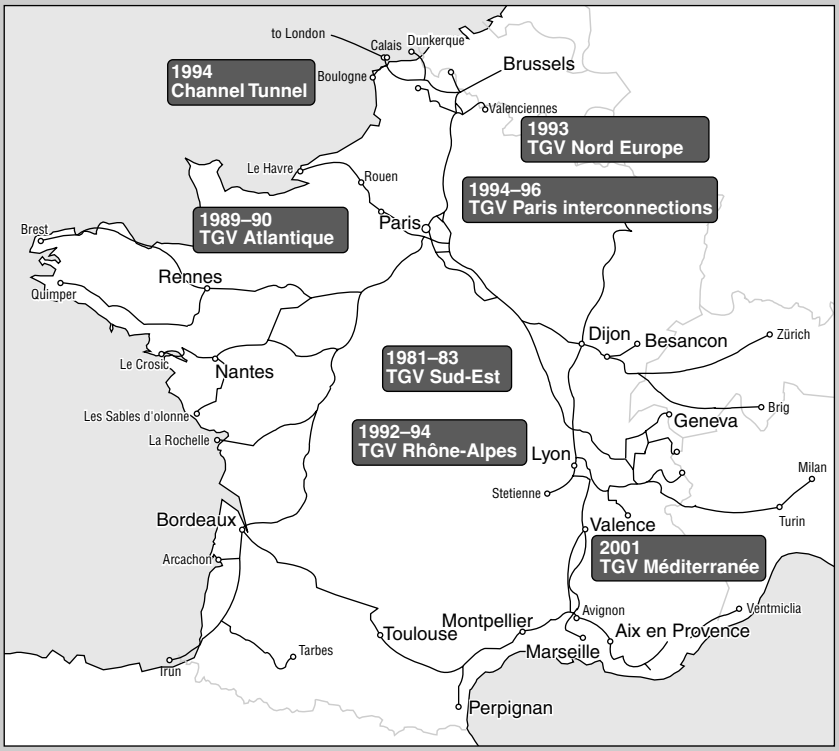


Figure 3 TGV Times from Paris

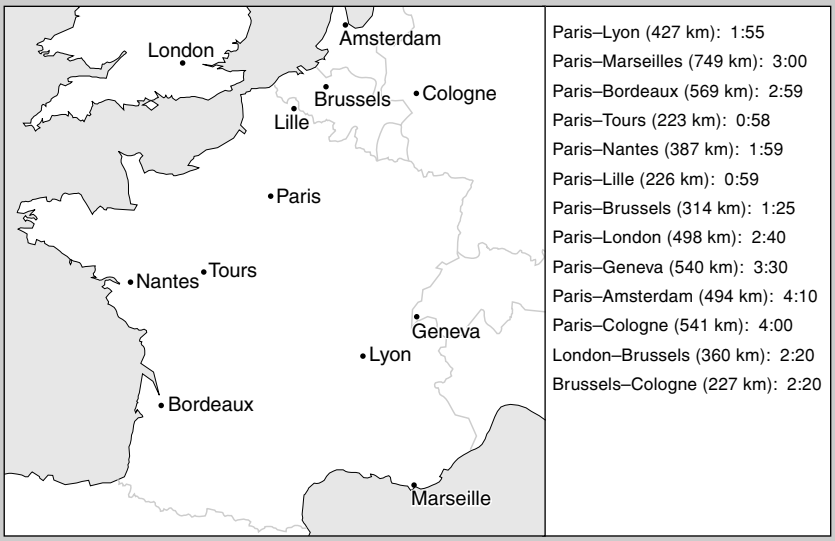


Table 2 TGV Train Sets

TGV Sud-Est
Fleet: 110
First service: 1981
Output: 6420 kW
Catenary design: 25 kV/50 Hz + 1500 Vdc + 15 kV/16.7 Hz
Train protection systems: TVM 300/TVM 430 + KVB
*Renovations in 1996 and 1999

TGV Atlantique
Fleet: 105
First service: 1989
Output: 8800 kW
Catenary design: 25 kV/50 Hz + 1500 Vdc
Train protection systems: TVM 300/TVM 430 + KVB

TGV Réseau
Fleet: 89
First service: 1993
Output: 8800 kW
Catenary design: 25 kV/50 Hz + 1500 Vdc + 15 kV/16.7 Hz
Train protection systems: TVM 430 + KVB + TBL + ATB + R54
* Of which 10 PBA

TGV Duplex
Fleet: 36
First service: 1996
Output: 8800 kW
Catenary design: 25 kV/50 Hz + 1500 Vdc
Train protection systems: TVM 430 + KVB

Eurostar
Fleet: 31
First service: 1994
Output: 12,240 kW
Catenary design: 750 Vdc + 25 kV/50 Hz + 3000 Vdc
Train protection systems: AWS/TPWS + TVM 430 + KVB + TBL
* 16 SNCF, 4 SNCB and 11 BR

Thalys
Fleet: 17
First service: 1996
Output: 8800 kW
Catenary design: 25 kV/50 Hz + 1500 Vdc + 15 kV/16.7 Hz + 3000 Vdc
Train protection systems: TVM 430 + KVB + TBL + ATB + Indusi + LZB
* 6 SNCF, 7 SNCB, 2 NS and 2 DB AG

(Photos: SNCF)

the TGV to serve the French regions without passing through Paris.
Moreover, TGV trains can also directly serve the UK, Belgium, the Netherlands, Germany, Switzerland and Italy.

Trip times

As shown in Figure 3, the TGV network has dramatically changed the geography of France in terms of trip times from Paris.

TGV Train sets

Concurrent with the high-speed line advances, SNCF has undertaken comprehensive development of TGV train set designs. The current fleet of 388 train sets contains five TGV generations, including *Eurostar* and *Thalys*, distributed as shown in Table 2.

TGV Success Story

Not only is the TGV a technical success, it is also a commercial success.
Since the first commissioning of the TGV in 1981, the TGV traffic volume has increased continuously as different TGV lines have come into service in the 20 years from 1981 to 2001 (Figs. 4 and 5). About 250,000 passengers take one of the 600 TGV trains operating each day; yearly TGV traffic totals 90 million passengers.
By the end of 2003, the TGVs had carried a total of more than 1 billion passengers, indicating their success as a fast, safe, frequent, comfortable and efficient means of transport accessible to all.
In term of passenger-km and commercial revenue, TGV traffic comprises about 75% of total SNCF main-line traffic. Operation of TGV trains in France and in neighbouring countries (including *Eurostar* and *Thalys* services) is a main profit centre for SNCF.
Experience shows an immediate reaction by the public after a new TGV is opened. Sources of increased traffic are passengers changing from air and road transport due to the value added by the TGV in term of shorter trip times, frequent services, high comfort and competitive fares.
The impact of high-speed rail on air travel is unquestionable; air routes in competition with the TGVs have all seen similar drops in volume, especially on journeys with a trip time of less than 3 hours. The impact on road transport is also clear—indices for traffic show that motorways in competition with TGVs experience a decrease in traffic growth. As an added benefit, the drop in air and road traffic decreases the negative impact of pollution, etc., on the environment due to the environment friendly nature of the TGV.

Synergy between TGV and Aeroplanes

France has developed the synergy between the TGV and air services to a great degree. For example, two airports—Roissy Charles de Gaulle Airport (CDG) near Paris, and Lyon Saint Exupéry (LYS)—have TGV stations in the airport itself. The TGV Air service from CDG combines international flights operated by many airlines and TGV journeys to form a unique trip on a single ticket to the following destinations: Aix-en-Provence TGV, Angers, Avignon TGV, Bordeaux Saint-Jean, Le Mans, Lille-Europe, Lyon Part-Dieu, Marseille Saint-Charles, Montpellier, Nantes, Nîmes, Poitiers, Rennes, Saint-Pierre-des-Corps Tours, Valence TGV. TGV Air is not only promoted by SNCF but also by travel agencies and world airlines. In 2004, Air France, Air Austral, American Airlines, Continental Airlines, Delta Air Lines, KLM, Lufthansa and United Airlines were all TGV Air partners, and other airlines are planning to join.

Figure 4 Annual Growth in TGV Traffic

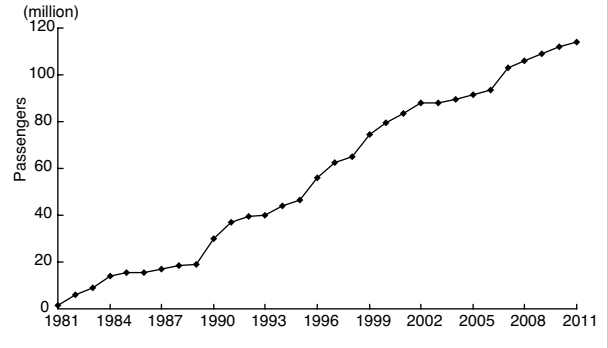
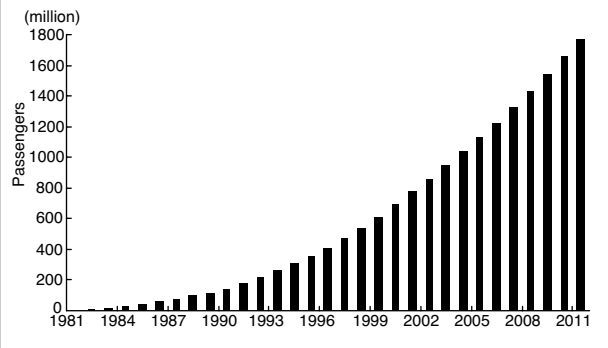


Figure 5 Cumulative TGV Passenger Totals



View of TGV Station and terminals at CDG (SNCF)

TGV Station in CDG (SNCF)

View of TGV station and terminals at LYS (SNCF)

TGV Station in LYS (SNCF)

TGV Station at Roissy Charles de Gaulle Airport

The TGV station in CDG Terminal 2 opened in 1994 to provide a quick and convenient connection between the train and plane. The station has four floors, offering various services, including information points, ticket windows, a bar, a restaurant, money changing, car rentals, children's nursery, showers, washrooms, etc.

The TGV services from CDG operate over the Nord Europe, Sud-Est, Méditerranée, and Atlantique TGV lines, as well as the *Thalys* network. In 2002, the CDG TGV station handled about 2.5 million passengers and this volume is expected to increase as the airport traffic grows.

TGV station at Lyon-Saint Exupéry Airport

The TGV station at the heart of LYS opened in 1994. It was designed by the famous Spanish architect M. Santiago Calatrava. The architecture is audacious, combining an aesthetic landmark exterior with internal functionality.

Since construction of the third airport for the Paris region was cancelled, LYS has lived up to its ambition to become the second largest airport in France. Its trump card is its connection with the expanding European high-speed network. This advantage will make LYS a unique multi-modal transport base for Europe. Currently, there are about 9 million people living within 90 minutes of LYS; by 2015, there will be 21 million people (excluding Paris) living within 2 hours.

In 2002, the TGV station at LYS handled 300,000 passengers, a 19% year-on-year increase. This traffic will continue growing in the future with additional TGV trains to the south and south-east of France and the commercialization of services like TGV Air, combining air flights with TGV trips—a perfect complement between train and plane.

TGV East under Construction

After the TGV Méditerranée, the next TGV project to be opened (in 2007) will be the TGV East from Paris to Strasbourg. The entire project comprises 406 km of new lines reaching to Vendenheim near Strasbourg. The first phase, which is

already budgeted for, comprises 300 km, linking Vaires-sur-Marne near Paris to Baudrecourt in the Moselle as well as to the existing railway network, serving as many destinations directly without the need to make a connection.

The project also includes improvements to terminal lines and facilities, especially between the Gare de l'Est station in Paris and Vaires-sur-Marne as well as on the Strasbourg–Kehl main line. Furthermore, the lines through the Vosges valleys will be electrified ready for the new high-speed trains. Thanks to the East France European HSR, Paris will be linked to the major cities of eastern France, and the eastern regions will be connected to the high-speed network serving northern, western and south-western France, giving birth to a new European network.

Speed and travel times

The first 300 km linking Vaires-sur-Marne to Baudrecourt in Moselle will support speeds up to 350 km/h—commercial operations will start at 320 km/h. Some typical journey times are shown in Figure 6.

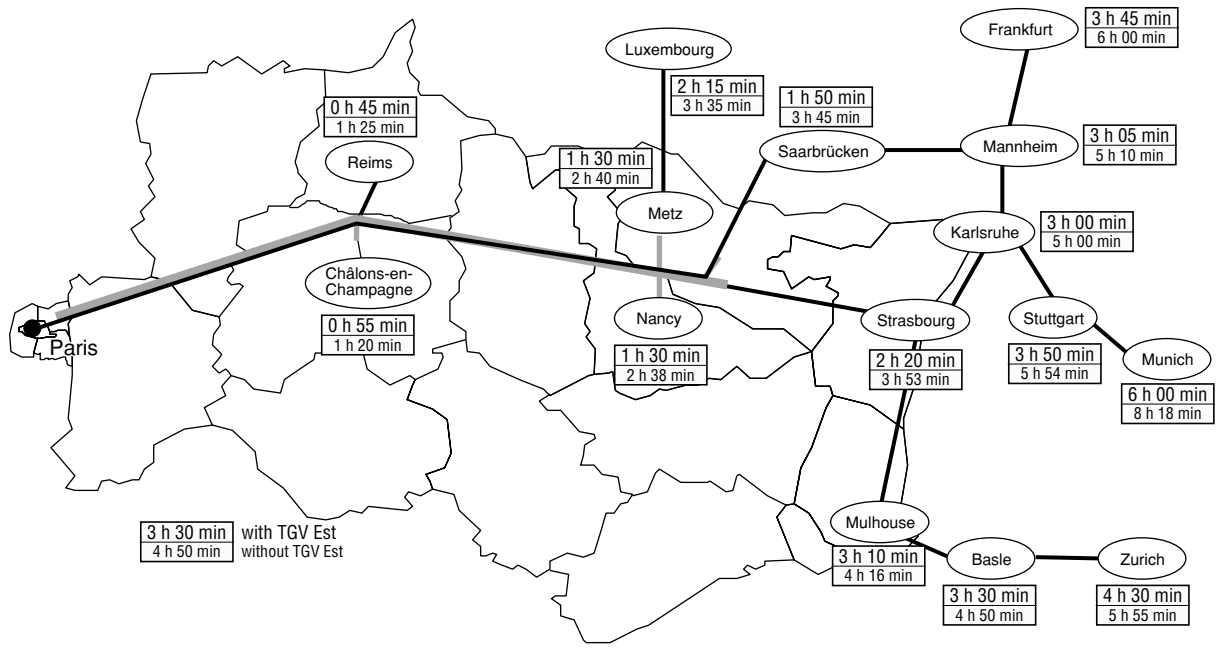
TGV Est financing

This project was born after many studies to define a specific financing package and a route respecting the natural environment and surroundings. As the first infrastructure project of its kind to be declared a public utility by the Ministry of the Environment, the East France European HSR line is also the first railways to be financed largely by the French regions and the European Union (EU). The total cost is about €4 billion (€1 = US$1.20) apportioned as follows: 61% public funds (French government, 17 local authorities, EU and Luxembourg); 17% RFF, and 22% SNCF (including €800 million for TGV rolling stock).

Commercial network and traffic forecast

With a 300-km new high-speed line from

Figure 6 TGV Est Journey Times



Paris–Remiremont: 2:45
Meuse region–Lille: 1:45
Meuse–CDG: 55 min
Lorraine–Rennes/Nantes: 3:50
Marne la Vallée (Disneyland Paris)–Champagne-Ardenne station: 0:35
Paris–Nancy/Metz: 1:30

Vaires to Baudrecourt and connections to conventional lines and the rest of the TGV network, the TGV Est will form a commercial network including 26 French and 11 European cities.

For the commercial international high-speed services, RHEALYS has been established as a joint venture by CFL (Luxembourg), SNCF (France), DB AG (Germany) and SBB (Switzerland).

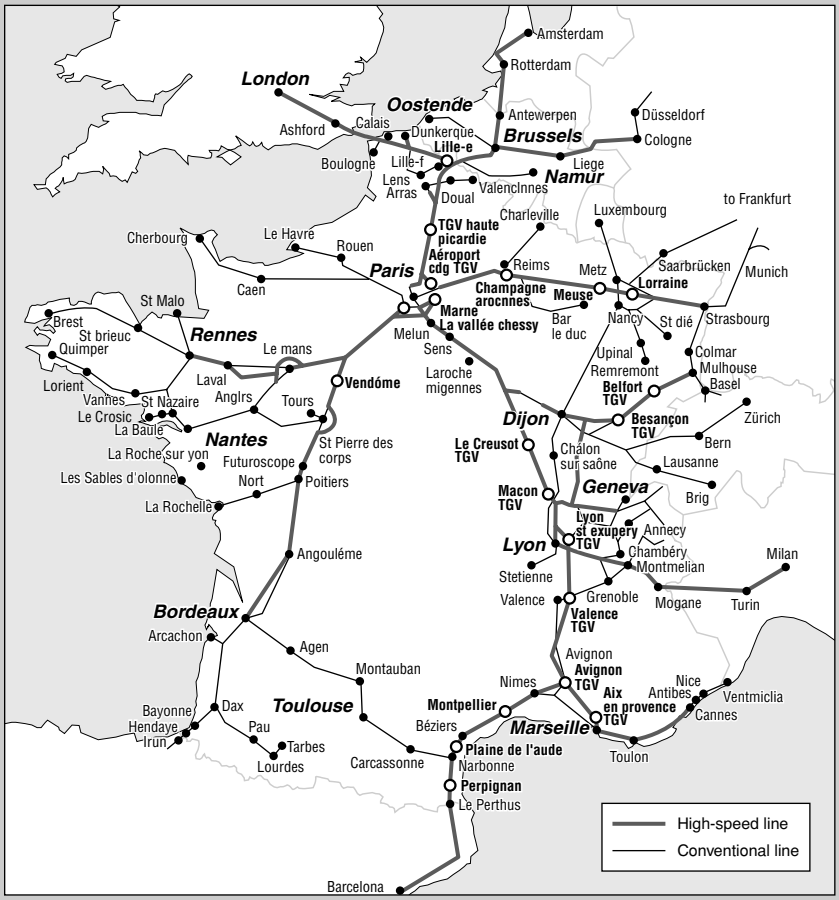
The project will increase traffic volumes by 66% from 6.9 million passengers to 11.5 million.

Future TGV Developments

The Inter-ministerial Committee on Territorial Planning and Development (CIADT) was held on 18 December 2003. One of the subjects was an ambitious long-term (2025) transport plan allowing better participation of the French regions in Europe and the world economy. The plan has about 50 big projects including eight TGVs (Fig. 7): Rhine–Rhone (Dijon–Mulhouse); Sud Europe Atlantique (Tours–Bordeaux–Spain); Bretagne–Pays-de-la-Loire; Est (second phase with connection to ICE network); Catalonia–Italy (Perpignan–Figueras, bypass around Nîmes and Montpellier, TGV to Nice); Lyon–Turin; Bordeaux–Toulouse; and Interconnection south of Paris.

By 2010, the French high-speed network will total 2117 km. In the longer term, the network will total about 3500 km. The TGV lines will also extend into neighbouring countries; the EU has recently adopted technical specifications for interoperability (TSIs) for the high-speed network that are mandatory for new EU high-speed lines. Their implementation will allow the EU to establish a high-speed network, totalling more than 12,000 km, integrating the European countries and revitalizing railway passenger transport. ■

Figure 7 Long-term Planned TGV Network



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