U.S. House of Representatives
Committee on Transportation and Infrastructure
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April 13, 2007

SUMMARY OF SUBJECT MATTER

TO: Members of the Subcommittee on Railroads, Pipelines, and Hazardous Materials

FROM: Subcommittee on Railroads, Pipelines, and Hazardous Materials Staff

SUBJECT: Hearing on International High-Speed Rail Systems

PURPOSE OF HEARING

The Subcommittee on Railroads, Pipelines, and Hazardous Materials is scheduled to meet on Thursday, April 19, 2007, at 10:00 a.m., in room 2167 Rayburn House Office Building, to receive testimony on international high-speed rail systems.

BACKGROUND

High-speed rail (HSR) is a form of rail transport which is commonly defined as trains that are electronically propelled at speeds exceeding 150 miles per hour (mph), and many trains have been tested in excess of 320 mph. At high speeds, trains must be completely grade separated, meaning there are no at-grade crossings with roads or other types of transportation. The tracks are fenced to prevent intrusion, and the trains must run on dedicated alignments with few stops to maximize performance. High-speed trains also must have sophisticated, modern signaling and automated train control systems.

HSR was first spawned with the Japanese "bullet trains", or Shinkansen trains, which in 1964 began operating at speeds of more than 150 mph. In 1981, France inaugurated a 255-mile HSR line between Paris and Lyon, cutting travel time from four hours to two hours. In 1991, Germany unveiled a 203-mile HSR service between Hanover and Wurzburg and a 62-mile HSR service between Mannheim and Stuttgart. Since then, other nations have created their own HSR lines: in 1992, Italy and Spain started new services; in 1998, Sweden upgraded its rail lines to accommodate HSR; and in 2000, the Netherlands started HSR service between Amsterdam and Brussels. By comparison, the only American line that can approach the speed of the European and Asian HSR systems is Amtrak's Acela line, which operates between Washington, DC and Boston. The Acela is capable of achieving speeds of up to 135 mph between Washington, DC and New York and 150 mph between New York and Boston, but usually averages considerably less than that (82 mph and 66 mph, respectively), largely due to congestion and track conditions.

On April 3, 2007, a French HSR train broke the world speed record for steel-on-steel rail when it achieved a speed of 357 mph on a new train set that the French plan to soon have in regular rotation. The world's fastest train is a magnetic levitation train built by the Japanese that reached 361 mph on December 2, 2003.

Today's HSR systems fall into two categories: steel-on-steel systems and magnetic levitation systems. Steel-on-steel high-speed rail systems are the most common. They operate on exclusive rights-of-way through a combination of electrification and other advanced components, expeditious alignments, and state-of-the-art rolling stock. The systems can attain performance well above what is capable with conventional rail technology.

The bulk of steel-on-steel research and development took place after World War II in Japan, France, and Germany. Japan introduced the world's first HSR train, the Shinkansen in 1964; France followed with its *train à grande vitesse* (TGV), and Germany with its Intercity Express (ICE). Other countries have since followed, including Italy, Spain, England, Belgium, China, Korea, and Taiwan. Although adhering to sometimes divergent design principles, these systems uniformly succeeded in reducing journey times and capturing increased traffic among the major cities served.

Magnetic levitation, or maglev, is an advanced transport technology in which magnetic forces lift, propel, and guide a vehicle over a special-purpose guideway. Utilizing state-of-the art electric power and control systems, this configuration eliminates the need for wheels and many other mechanical parts, thereby minimizing resistance and maximizing acceleration, with cruising speeds on the order of 300 mph.

There are two basic types of maglev systems. One system utilizes attraction forces, where electromagnets exert force on an iron rail on the guideway to effect levitation. The second system uses repulsion forces, where superconducting magnets move across coils or aluminum plates on the guideway to levitate and propel the vehicle. Typically, the attraction-force maglev system has a gap of about one-half inch and can be levitated at zero speed. The repulsion-force maglev system has a gap of about four inches and must be in motion for levitation to occur.

The German company Transrapid has developed attraction-force maglev technology. This technology is the first maglev system in commercial use; it has been deployed in Shanghai, China, where maglev trains connect the city with its airport. The 19-mile track came online October 11, 2003 at a cost of approximately $1.2 billion. On March 23, 2007, the *Shanghai Daily* reported that Shanghai received state approval to extend the line to the Hongqiao Airport near the city of Hangzhou, the capital of neighboring Zhejiang province. The cost of the extension is expected to be $4.5 billion, and would reduce the rail traveling time from two hours to 30 minutes.

According to the Federal Railroad Administration, the initial average capital cost of available maglev technologies ranges from $40 to $100 million per rail mile. Compared to the $10 to$45 million per mile cost of steel-on-steel systems and the $1 to $10 million range for conventional rail, maglev technologies are the most expensive in terms of up-front investment.

Overview of Select High-Speed Rail Systems

The current leaders in high-speed rail systems are France, Germany, and Japan. China and Britain's Eurostar are also interesting in that China has invested an enormous amount of capital in its passenger rail system, and the Eurostar system is possible due to one of the greatest engineering feats in the world, the tunnel underneath the English Channel. Each system was developed based on different infrastructure needs, and has demonstrated different results.

France's High-Speed Rail System

At the end of 2005, France had 18,144 miles of track in revenue service, of which 963 miles were high-speed rail lines. According to the Government Accountability Office, France's system comprises the largest use of high-speed trains in the world.

France's major rail companies were nationalized in 1938 and put under the direction of the newly created *Société Nationale des Chemins de Fer Français* (SNCF). In 1991, the European Union (EU) issued Directive 91/440/EEC, which directed member states to separate infrastructure from operations in the form of separate accounts. According to the EU, this was done to help improve international rail travel between EU countries. As a result, in 1997, France restructured its railways.

SNCF infrastructure assets were transferred to a new state-owned company, *Réseau Ferré de France* (RFF), which assumed responsibility for railway infrastructure investment in France. As payment for the infrastructure assets, RFF took over a large amount of SNCF debt (about $18 billion). At the same time, SNCF's debt was reduced further from a transfer of funds to a Special Debt Account, which is not recorded on SNCF's balance sheet. According to a report commissioned by the EU, France's restructuring had more to do with spreading out the historic debt of its railways than it had to do with the EU directive. SNCF and RFF have high debt levels (95 percent and 70 percent respectively). SNCF is currently adequately funded by the government, but RFF's new debt is rising sharply.

Under the new structure, SNCF, which is comprised of about 200,000 workers, is responsible for the operation of infrastructure, track allocation, timetabling, and access pricing though the infrastructure is owned by RFF. RFF, which is comprised of about 700 workers, requires SNCF to undertake all maintenance and renewal activities; this relationship is set out in a contractual agreement, which specifies the payments RFF will make to SNCF and the infrastructure quality standards that SNCF is required to deliver. SNCF determines the maintenance activities that it will undertake to meet these criteria and to satisfy the requirements of its train operations and safety standards. RFF, on the other hand, prepares investment plans for infrastructure enhancements, on which SNCF is consulted. New infrastructure projects are contracted out by RFF on the basis of competitive tender. SNCF has won many, but not all, of these contracts.

SNCF and RFF are governed by Boards of Directors. The French government appoints 12 of the 18 members of the SNCF Board of Directors, seven of whom (including the chairman) are required to be French government employees. RFF's board has a similar composition.

France's high-speed rail system is composed of high-speed track (*Lignes à Grand Vitesse*, "high-speed lines," or LGVs) and high-speed trains (*Trains à Grand Vitesse*, "high-speed trains," or TGVs). In 1981, SNCF began high-speed operations with the opening of the Paris-Lyon TGV line. SNCF reports that its TGVs command a dominant share of the air-rail travel market in several of its corridors – over 90% in the Paris-Lyon market (with a travel time of less than 2 hours) and about 60% where the travel time is 3 hours (Paris-London, Paris-Marseilles).

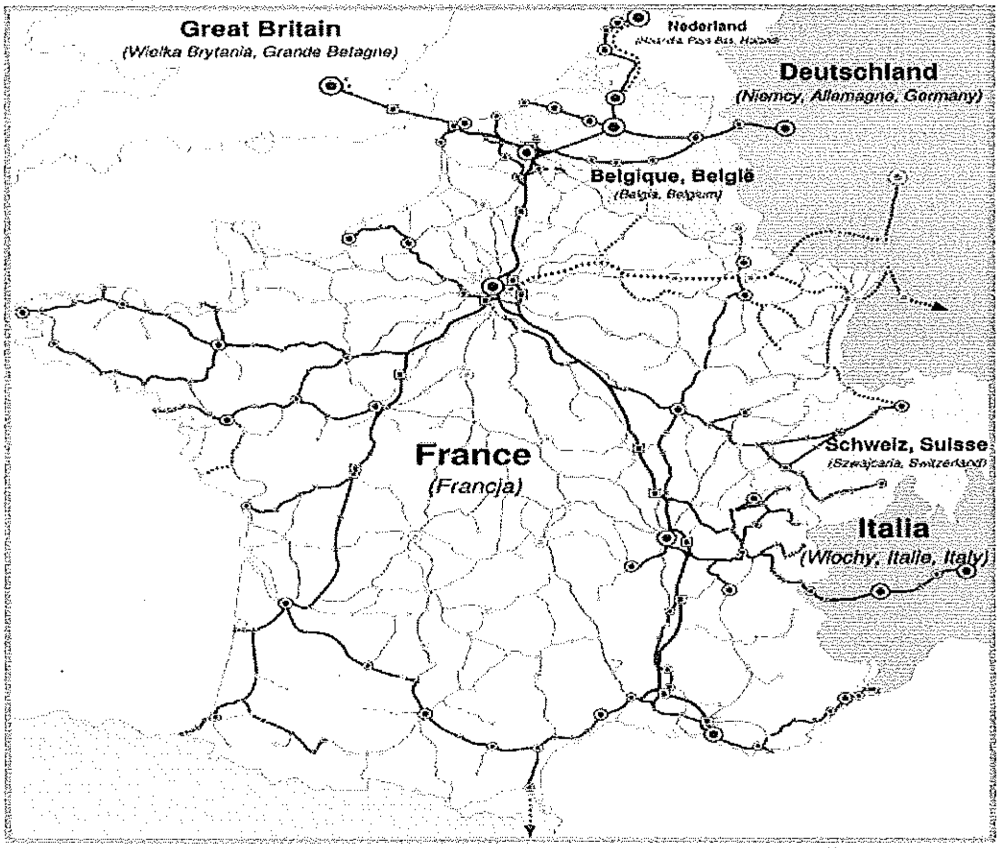
Because of France's relatively low population density and the centrality of Paris (as the capital, the largest population center, and the geographical center of the northern part of the country), the LGV network has taken the form of spokes radiating outward from the hub of Paris to other population centers (seen on next page). Several LGVs are under construction and several more are being planned. Funding for construction of domestic LGVs is largely provided by the French government; for lines crossing into other countries, funding comes from several sources, including the respective countries and European investment agencies.

On the LGVs, the maximum speed is 186 mph though some sections are limited to 168 mph. A new LGV, LGV Est Européene (East European high-speed line), running from Paris to Strasbourg, is being built to allow 217 mph operation, but will initially be limited to 199 mph. The line will be 405 km (252 miles), and is scheduled to open in 2010. The first section, linking Vaires-sur-Marne near Paris to Baudrecourt in the Moselle (186 miles), is scheduled to begin service in June 2007, cutting the travel time from Paris to Strasbourg from four hours to a little over two hours. TGV trains may also run along conventional tracks, but their speeds are limited to 137 mph on these sections.

The Nord-Pas de Calais region is proposing to develop a regional high-speed rail network, with a mix of new and upgraded lines allowing speeds of 155 to 186 mph, likely using refurbished TGV train sets.

In 2005, SNCF carried 974 million passengers, of which 95 million (10%) were TGV passengers; the remainder were regional passengers (roughly comparable to commuter rail and transit service in the U.S.).

THE TGV NETWORK



Source: www.raileurope.com

PUBLIC FINANCING OF FRENCH NATIONAL RAILWAYS

According to an April 2005 study of public budget contributions to railways in Europe, which was commissioned by the European Union, France provided, on average, about 7.3 billion euros ($9.8 billion US) per year for each of fiscal years 1995 through 2003. In 2003, for example, public budget contributions to the French railway system totaled about €9 billion ($12 billion US) in 2002 and €8 billion ($10.7 billion US) in 2003, which can be broken down as follows:

- RFF's main sources of income are infrastructure access fees paid by SNCF, and contributions from the state. Both are accounted for as operating revenue. The state contribution in 2002 and 2003 was around €1.4 billion ($1.88 billion US) a year.

- RFF has in most years received capital infusions from the state. In 2002, an equity contribution of €1.36 billion ($1.82 billion US) was received, allowing RFF debt to be broadly stabilized in that year. In 2003, no equity injection was given and, as a result, RFF debt increased by €1.5 billion ($2 billion US) in that year.

- RFF receives capital grants from central and regional authorities for infrastructure projects. In 2003, the capital grants amounted to €981 million ($1.3 billion US), up from €552 million ($741 million US) in 2002 and €264 million ($354 million US) in 2001.

- SNCF receives state contributions for tariff and public service obligations for regional and local services, for concessionary fares, and for various other services. These contributions totaled around €2.1 billion ($2.8 billion US) in 2003 and €2 billion ($2.6 billion US) in 2002. In both years, SNCF also received investment subsidies (€618 million, or $830 million US, in 2003 and €721 million, or $969 million US, in 2002).

- The state pays a retirement supplement for SNCF staff, which is not shown on SNCF's income statement, amounting to €2.4 billion ($3.2 billion US) in 2003 and €2.3 billion ($3.09 billion US) in 2002.

- The Special Debt Account is an off-balance sheet commitment containing SNCF historic debt, for which the French state makes public contributions. In both 2002 and 2003, state contributions to this account were €677 million, or $909 million US.

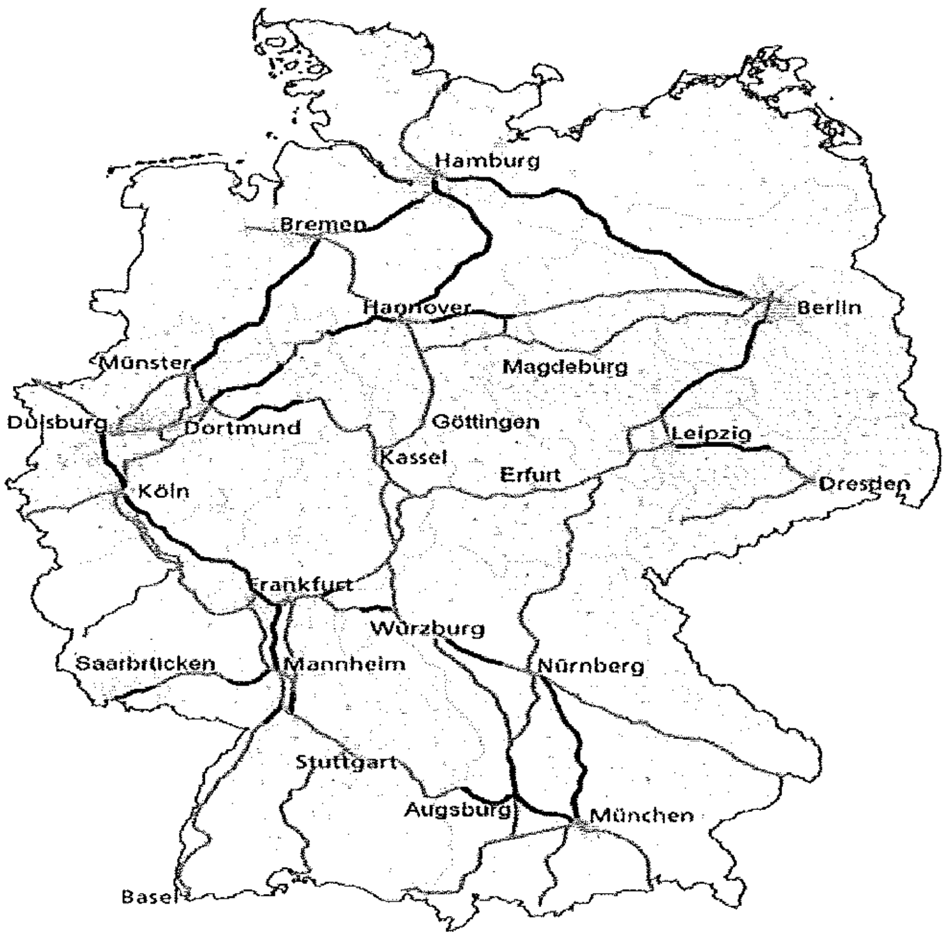
GERMANY'S HIGH-SPEED RAIL SYSTEM

Construction on the first German HSR lines began shortly after that of the French LGVs. The first generation of ICE trains were introduced in 1991, operating at a maximum speed of 155 mph on new tracks; a second generation was put into service in 1997, which operate at 174 mph on new track; and a third generation train was put into service in 2000, which can operate at speeds up to 186 mph on new track.

There are three distinct differences between the French and German HSR systems: (1) the ICE makes more stops at intermediate destinations, compared to the TGV trains, which tend to focus on connecting distant cities with few intermediate stops; (2) Germany focused on upgrading existing rail lines rather than building new high-speed rail track; and (3) most ICE services run on conventional rail lines, with the exception of the Cologne-Frankfurt line, while the TGV mainly runs on dedicated HSR lines. Speeds on the conventional rail lines are limited to 125 mph.

Running higher-speed trains with conventional trains on the same tracks has caused significant scheduling and operational difficulties for German rail operators. Often, the faster trains will catch up to the slower trains, causing significant delays. Deutsche Bahn AG, the state-owed rail operator, has unveiled a plan, Netz 21 (Network 21), to reduce delays and expand capacity on its rail network. The plan calls for upgrading existing trains, installing more modern control systems for better scheduling rail traffic, and constructing new lines and upgrading existing lines to reduce bottlenecks. Deutsche Bahn, however, states that the pace and extent of the network expansion "will depend largely on transport policy and the amount of infrastructure funding provided by the federal government."

THE ICE NETWORK



Source: http://www.ice-fanpage.de/

As noted earlier, Germany also developed a maglev train system, the Transrapid, which can reach speeds up to 340 mph. A test track with a total length of 19.5 miles is operating in Emsland, Germany. Unfortunately, 23 people died when this elevated maglev train collided with on-track maintenance equipment on September 22, 2006 near Lathen in northwestern Germany. Despite this accident, the technology has been successful in China, where it was used in building the Shanghai Maglev train.

PUBLIC FINANCING OF GERMANY'S RAILWAYS

According to an April 2005 study commissioned by the European Union, total government spending for regional rail transportation in Germany was €4.5 billion ($6 billion US) in 2003. It is unclear from documents obtained by staff whether this includes HSR investment. In addition, €2.3 billion ($3 billion US) was allocated in 2003 to all public transport modes for operations and infrastructure investment. Some of those funds were used for rail. The German government also continues to pay-down the historic debt of its two former public railways, which operated in East and West Germany prior to reunification. After reunification, the two railways merged into

Bundeseisenbahnvermoegen, out of which Deutsche Bahn (the German National Railways) was then created. The historic debt of the two railways was DEM 68 billion in 1994 (then $38 billion US). The amount allocated by the German government for debt service in 2003 was €8.7 billion ($11.6 billion US).

JAPAN'S HIGH-SPEED RAIL SYSTEM

Japan is perhaps France's biggest rival when it comes to high-speed rail. It was the unveiling of Japan's first high-speed train, the Tokaido Shinkansen (or New Trunk Line, in English), that spurred France to develop the TGV. Construction began in 1959, and in 1964, the world's first high-speed rail line was unveiled to the public on the eve of the Tokyo Olympics, then operating at a speed of 200 km/h (about 125 mph).

Japan is an extremely densely populated country: more than 70% of the land surface is mountainous and thus uninhabitable or unsuitable for road travel and parking. In fact, parking is so sparse that drivers must prove they have a parking space before they can buy a car. With such a high population density, the only practical possibility for transportation across the country is rail. In fact, after World War II, the Japanese government officially deemed rail as the preferred mode of travel.

The recognition of the interrelationship between land development and the high-speed rail network led, in 1970, to the enactment of a law for the construction of a nationwide Shinkansen railway network. By 1973, the Ministry of Transport approved construction plans for five additional lines and basic plans for 12 others. Despite the approval, financial considerations intervened; the cost of the five lines (five trillion yen, or roughly $18 billion US at the 1973 exchange rate), combined with the recession in the 1970s and early 1980s resulted in some lines being cancelled and others delayed until 1982.

Today, Japan has eight Shinkansen lines: Akita Shinkansen, Joetsu Shinkansen, Yamagata Shinkansen, Hokuriku Shinkansen, Tohoku Shinkansen, Sanyo Shinkansen, Kyushu Shinkansen, and Tokaido Shinkansen. The trains travel between 260 km/h and 300 km/h (about 160 mph and 185 mph).

Japan is planning construction of four new Shinkansens: the Tohoku Shinkansen and Kyushu Shinkansen, which will be completed by March 2011; the Hokuriku Shinkansen, which will be completed by March 2015; and the Hokkaido Shinkansen, which will be completed by March 2016. In addition, incremental improvements to the high-speed rail technology have been undertaken. Tilting trains have been introduced to take curves faster; meanwhile, aerodynamic redesigns, stronger engines and lighter materials, air brakes, typhoon and earthquake precautions, and track upgrades are among the developments. As a result of improvements, the travel time from Tokyo to Shin-Osaka (the first route opened) has decreased from four hours in 1964 to two and one-half hours, and is forecast to be less than two hours in the near future.

In addition, a new generation of conventional steel wheeled Shinkansen trains FASTECH 260 with a top speed of 405 km/h (about 250 mph) and an operational speed of 260 km/h (160 mph) is currently under development. Production trains are expected to enter service in 2011.

A Japanese consortium led by the Central Japan Railway Company has been researching new high-speed rail systems based on maglev technology since the 1970s. Although the trains and guideways are technology ready and over 100,000 people have ridden them, high costs remain the primary barrier. Test trains JR-Maglev MLX01 on the Yamanashi test line have reached speeds of 581 km/h (361 mph), making them the fastest trains in the world. These new maglev trains are intended to be deployed on new Tokyo-Osaka Shinkansen maglev route, called the Chuo Shinkansen, though the project has little political support, due to cost of deployment (10 trillion yen, or $84 billion US).

PUBLIC FINANCING OF JAPAN'S HIGH-SPEED RAIL SYSTEM

HSR lines are built through the mutual consent of the local governments and the relevant Japanese Railway (JR) Company. New lines are paid two-thirds by the federal government and one-third by the prefecture (local) government. In addition, the JR Company using the line pays a usage fee to the government, though in some cases a JR Company may purchase the line from the government and maintain the line itself. The federal subsidy for the Shinkansen in 2006 was 151 billion yen, or a little less than $1.3 billion, and the local government subsidy was 75.5 billion yen, or $633 million US.

CHINA'S HIGH-SPEED RAIL SYSTEM

China is undergoing a period of substantial economic and social growth that is necessitating a massive investment in its transportation infrastructure. According to China's Ministry of Railways, in 2006, a quarter of the world's railway transportation volume (freight) occurred in China. As such, China has embarked on a plan to upgrade and expand its national rail network through 2010.

In accordance with the plan, in 2006 alone, China invested $32 billion in expansion of its rail network. For 2007, of the $119 billion China plans to invest in transportation infrastructure, the Ministry of Railways reports that $42.6 billion will go to rail expansion. This includes 377 miles of new track, 393 of double tracking, and 1,255 miles of electric track for high-speed rail use. The total investment for rail infrastructure will be $190 billion between 2006-2010, according to China's National Development and Reform Commission, and will increase China's total rail infrastructure by 20 percent.

The Chinese government has identified HSR as the future of its passenger rail system, but China's expansion into high-speed rail travel is just beginning. It does not have high-speed rail service between major cities, but it does have high-speed rail service between Shanghai and Pu Dong International Airport. The Shanghai Maglev Train, a Transrapid maglev project imported from Germany, is capable of an operational speed of 430 km/h (267 mph) and a top speed of 501 km/h (311 mph).

China has decided to build a second Transrapid maglev rail, which will stretch 99 miles from Shanghai to Hangzhou. Construction was expected to begin in early 2007 and be complete in time for the 2010 Shanghai Expo. It would be the first intercity maglev rail line in commercial service in the world.

In addition to the maglev lines, a conventional high-speed rail line based on ICE technology between Beijing and Tianjin is expected to open in 2007. The Beijing-Shanghai Express Railway is also in an advanced phase of construction but it will only allow speeds of 200 km/h (124 mph).

SPAIN'S HIGH SPEED RAIL SYSTEM

RENFE is the national rail passenger operator in Spain and is a Government-owned company controlled by the ministry of public works (Ministerio de Fomento). RENFE is primarily funded by the federal government, although the regional governments provide some additional funding and are undertaking a greater role in planning transport infrastructure. At present, RENFE both operates trains and manages all the infrastructure, including the Madrid-Seville high-speed line. The government has recently proposed to set up a new body, ADIF, which would take over all of Spain's rail infrastructure, in order to be compliant with European law which mandates management separation of operations from infrastructure. A separate state-owned organization, GIF, is responsible for development of the high-speed lines that are under construction, but, if the new rail structure proposed by the government becomes law, responsibility for the construction and maintenance of new lines will transfer to ADIF.

In addition to RENFE, there are three other passenger rail operators but only one of these, FEVE, provides long distance services and these are all on its own dedicated narrow-gauge tracks. FEVE is also a state owned company controlled by Ministerio de Fomento.

Rail market share in Spain is very low by European standards: within the EU, it is lower only in three countries (Ireland, Portugal and Greece); 4.8% of domestic trips and 5.2% of domestic passenger kilometers are made by rail. The market share of bus transportation is more than twice this level and on some routes buses provide a faster and more frequent service than rail.

Spain has a poor quality conventional rail network, particularly if compared to countries such as France, Italy, or even the UK. Capacity is limited by long sections of single track, and line speeds are low as a result of curves and gradients. Tilting trains have long been used in Spain in order to minimize the impact of this on passenger journey times, but these can still be very long by European standards. Madrid to Barcelona, a similar distance to London to Edinburgh, takes seven hours by train at present. As a result, high-speed rail offers greater time savings in Spain than elsewhere in Europe, strengthening the case for investment.

The political decision to invest in high-speed rail was, in effect, made when the government committed that all regional capitals should be within four hours of Madrid and six hours of Barcelona by high-speed train. The first high-speed railway to be constructed in Spain was the Madrid to Seville AVE, which opened in 1992. Parts of two other major routes (Madrid-Valencia and Barcelona-Valencia) have been upgraded for fast operation and are both defined as high-speed by the Spanish government.

The Madrid to Seville high-speed line is perceived as having been very successful both in transport terms and in terms of its economic effects. Journey times are about 60% faster than via the old line, and 99.8% of trains arrive within three minutes of their scheduled arrival time (the corresponding figure for UK Intercity trains is 70% within 10 minutes). This has increased the public and political pressure to deliver the rest of the high-speed rail program, which the government is in the process of doing. Several routes are under construction, and the government has targeted 7,200km (4,500 miles) of high-speed railway along five main corridors. Only 725km of this total is complete, although another 1,146km (712 miles) is under construction, with an additional 1,182km (734 miles) in design, 920km (571 miles) in planning, and 3,227km (2,005 miles) in consultation.

The Spanish government has thus far allocated €41 billion ($55 billion US) for the construction of the new high-speed rail corridors. In addition, according to the European Union, the Spanish Government provides about €1.349 billion ($1.8 billion US) per year for passenger rail operations and infrastructure maintenance.

EUROSTAR

Eurostar is the high-speed rail service directly linking London to France and Belgium via the Channel Tunnel. It started operating in 1994. The Channel Tunnel is a 31-mile long rail tunnel beneath the English Channel starting at the Straits of Dover in England and ending in Coquelles, France. It was completed after seven years of work in 1994 at a cost of $15 billion. The tunnel consists of three interconnected tubes: one rail track each way plus one service tunnel. Its length is 31 miles, of which 23 miles are underwater. Its average depth is 150 feet under the seabed. The ninety-five miles of tunnels were dug by a workforce of nearly 13,000. Only 20 minutes of the Eurostar journey takes place in the tunnel. It is the second-longest rail tunnel in the world, with the Seikan Tunnel in Japan being longer, but the undersea section of 39km (23 miles) is the longest undersea tunnel in the world. The American Society of Civil Engineers has declared the tunnel to be one of the Seven Wonders of the Modern World.

Eurostar runs up to 16 trains to Paris and nine to Brussels daily. The fastest London-Paris Eurostar journey time is 2 hours 35 minutes, London-Brussels 2 hours 15 minutes and London-Lille just 1 hour 40 minutes. In addition, Eurostar offers connecting tickets to over 100 destinations across France, Belgium, and the Netherlands. For example, Lyon can be reached in five hours from London and Marseille from London in seven hours. The Eurostar trains can reach 186 mph, but may only travel 100 mph while in the Tunnel. In 2006, Eurostar had a ridership of approximately 8 million riders, according to Eurostar.

Since 1994, Eurostar has established itself as the leading carrier to Brussels and Paris and has the largest share of the rail/air market on its core routes despite intense competition. Eurostar has 69% of the London-Paris rail/air market and 62% of the London-Brussels rail/air market.

Originally, Eurostar was owned by the SNCF, SNCB, and British Rail. Prior to the UK privatization, a subsidiary, European Passenger Services (EPS) was created as a government-owned business which included British Rail's interest in Eurostar. In June 1996, this was sold to London & Continental Railways (LCR). In October 1996, LCR changed the name to Eurostar UK Ltd (EUKL). Today, EUKL, SNCF, and SNCB are each responsible for running Eurostar services on their own territory.

WITNESSES

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