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High-Speed Rail
International Lessons for U.S. Policy Makers

PETRA TODOROVICH, DANIEL SCHNED, AND ROBERT LANE

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Policy Focus Report Series

The policy focus report series is published by the Lincoln Institute of Land Policy to address timely public policy issues relating to land use, land markets, and property taxation. Each report is designed to bridge the gap between theory and practice by combining research findings, case studies, and contributions from scholars in a variety of academic disciplines and from professional practitioners, local officials, and citizens in diverse communities.

About This Report

This report was prepared with the Regional Plan Association as part of the Lincoln Institute/Regional Plan Association joint venture partnership known as America 2050. This is the third report on high-speed rail generated by America 2050 since 2009, when the U.S. High-Speed Intercity Passenger Rail Program was launched. The program has made investments of $10.1 billion in high-speed and conventional passenger rail corridors across the country. Previous reports by America 2050 proposed a federal decision-making framework for investments in high-speed rail based on regional factors that contribute to ridership demand, such as population density, employment concentrations, the presence of rail–transit connections, and existing intercity traffic flows.

This report assembles key lessons and research on the potential benefits of high-speed rail, drawn from nearly 50 years of experience with this mode of transportation in more than a dozen countries across the globe. Intended for policy makers, professionals, and interested citizens, it documents the approaches to high-speed rail that best leverage public investments for transportation benefits, economic development, and environmental and safety concerns. In the context of a new and controversial U.S. commitment to major high-speed rail projects, such as the statewide California system, this report offers recommendations for federal policy and explores various funding and financing strategies, as well as ideas about station location and design. It points to the Northeast Corridor and California as the two most promising regions in which to pursue high-speed rail initially, and suggests steps toward building support for those projects.

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ON THE COVER:
Germany's Inter-City Express (ICE) high-speed rail system began operation in 1991.

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Executive Summary

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The departures board at Paris's Gare du Nord TGV station.

High-speed rail has been adopted throughout the world, and is now being planned and developed in the United States. Over the past 50 years, U.S. transportation spending has favored the development of interstate highway and aviation systems. In the meantime, countries such as China, Japan, Spain, France, and Germany have been investing in modern high-speed rail systems to satisfy the travel demands of current and future generations. As the United States embarks on the High-Speed Intercity Passenger Rail Program launched in 2009, it can learn from the experiences of other countries in planning, constructing, and operating high-speed rail.

In 2009–2010, the U.S. Congress appropriated $10.1 billion for a new high-speed and intercity passenger rail program. Applications from 39 states requested nearly $75 billion, demonstrating broad interest in and support for this program. The available funds were awarded to dozens of conventional intercity passenger rail projects and a few dedicated high-speed rail projects in 32 states and the District of Columbia, and those projects are now moving forward.

The U.S. Department of Transportation, which manages the passenger rail program, has adopted a tiered approach, which emphasizes investments appropriate to the different markets and geographies in the United States. It defines three categories of passenger rail service that are intended to work together as a network: Core Express refers to high-speed trains operating on dedicated tracks with frequent service; Regional service operates at moderately high speeds and high frequency on shared corridors; and Emerging/Feeder service is less frequent and connects smaller and emerging markets to major markets located along Regional and Core Express routes.

Decades of international experience with high-speed rail suggests that it could create similar transportation, economic, environmental, and safety benefits in American cities and regions. While it requires high upfront investment, high-speed rail promotes economic growth by improving market access, boosting productivity of knowledge workers, expanding labor markets, and attracting visitor spending. When planned thoughtfully with complementary investments in the public realm, high-speed rail can promote urban regeneration and attract commercial development, as shown in several European examples. High-speed rail has greater operating energy efficiency than competing modes and takes up less land than highways.

The initial investment of $10.1 billion in the U.S. High-Speed Intercity Passenger Rail Program, after years of minimal federal investment, required that the federal government and participating states quickly scale up to the challenge of laying the groundwork for a foundational program and implementing it at the same time. Those states that had the staff capacity, expertise, and experience in rail planning, such as Illinois, North Carolina, and Washington, were successful in securing high-speed rail grants. However, carrying the momentum of this initial investment forward has proven to be a struggle in a difficult fiscal environment, and California is currently the only federally funded Core Express high-speed rail project moving forward. In 2011, Congress voted to strip funding from the program. The expiration of the legislation authorizing the high-speed rail program in 2013 may provide an opportunity to consider policy changes.

This report describes several funding strategies that have proven to be successful in other countries, and makes specific policy recommendations to better position the federal high-speed rail program for success.

Strengthen the federal policy and management framework by expanding the federal role in planning and prioritizing high-speed rail corridors and working with the states to secure rights-of-way.

Prioritize corridors that meet investment criteria by clarifying the objectives and desired outcomes of the federal program and promoting investments in those corridors that exhibit the characteristics that are indicative of success.

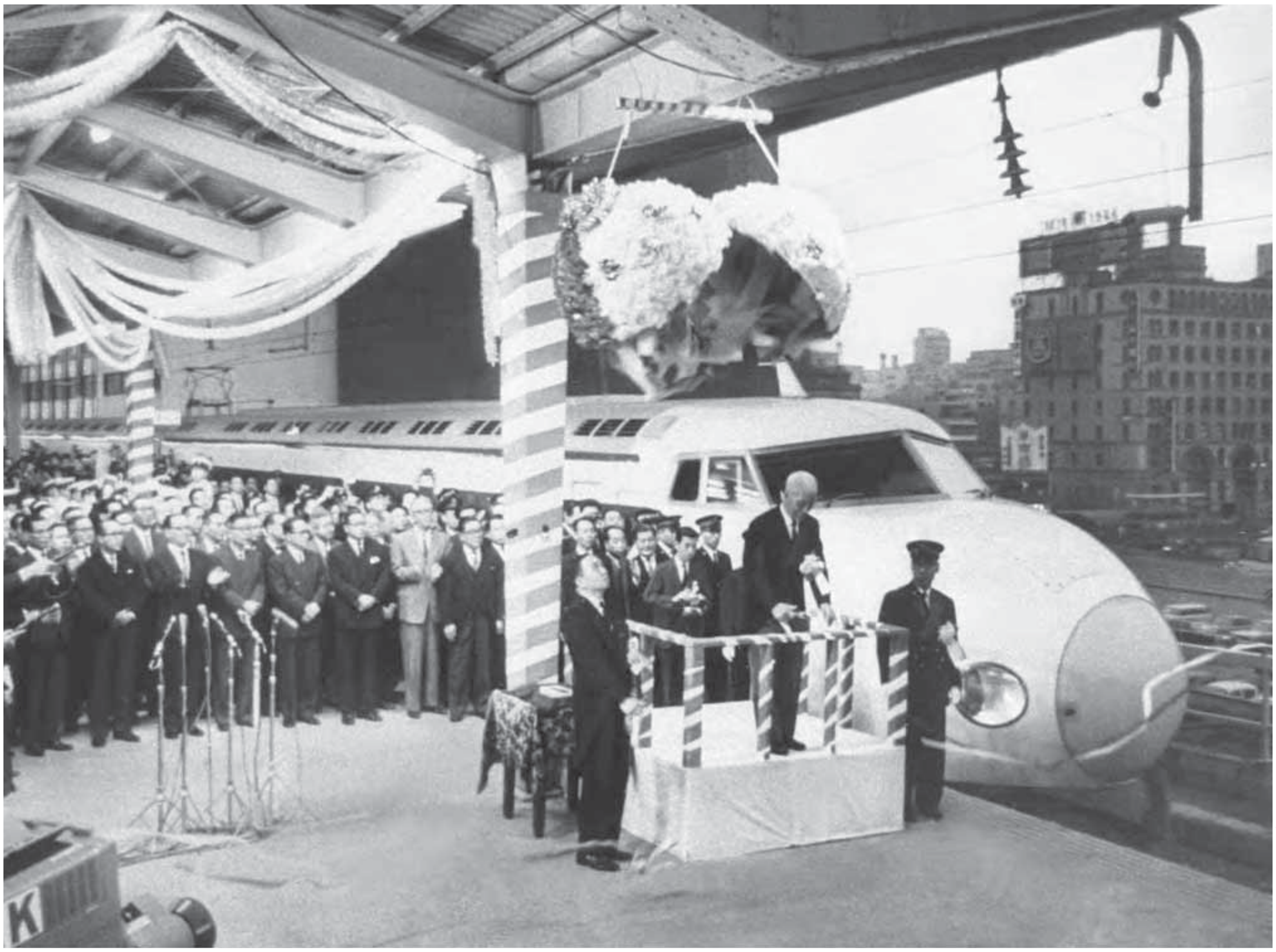
Establish new mechanisms for corridor management by developing legislation that enables the creation of public infrastructure corporations that can operate across state and national borders and attract private investment.

Plan for maximum land development benefits by coupling high-speed rail station investments with policies that encourage land development around station areas. In general, well-connected stations in center-city locations offer the greatest potential for urban revitalization.

Focus initially on the Northeast Corridor and California, which offer the best opportunities for Core Express high-speed rail service in the United States, by addressing the management and financing challenges each region faces.

Secure adequate and reliable funding by drawing on a full complement of potential federal, state, and private sources. Such sources could include increasing existing transportation-related fees (such as a portion of the gas tax or ticket surcharges), creating an infrastructure bank, forging public-private partnerships, and expanding existing credit assistance programs.

CHAPTER 1
International Experience with High-Speed Rail



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The Tokaido Shinkansen bullet train was launched on October 1, 1964, at Tokyo Station.

Since the 1964 inauguration of Japan's first *Shinkansen* bullet train connecting Tokyo to Osaka, commercial high-speed rail lines have been constructed in 14 countries. Together these lines provide billions of passenger trips, save many hours of travel time, and provide an exceptional level of safety. Now considered a well-established and proven technology, high-speed rail continues to offer benefits to the nations and regions it serves. This reliable, rapid, and safe ground transportation system offers increased regional mobility and accessibility, reduces fuel use, saves energy, regenerates cities and regions, and increases economic productivity.

With the exception of the higher-speed Acela Express service operated by Amtrak on the Northeast Corridor, the United States has failed to develop high-speed rail and fully realize its benefits, despite numerous planning studies and aborted attempts to expand rail service in various regions since the 1960s. As a result, most Americans are unfamiliar with high-speed rail and its potential impacts on our cities, regions, and national landscape.

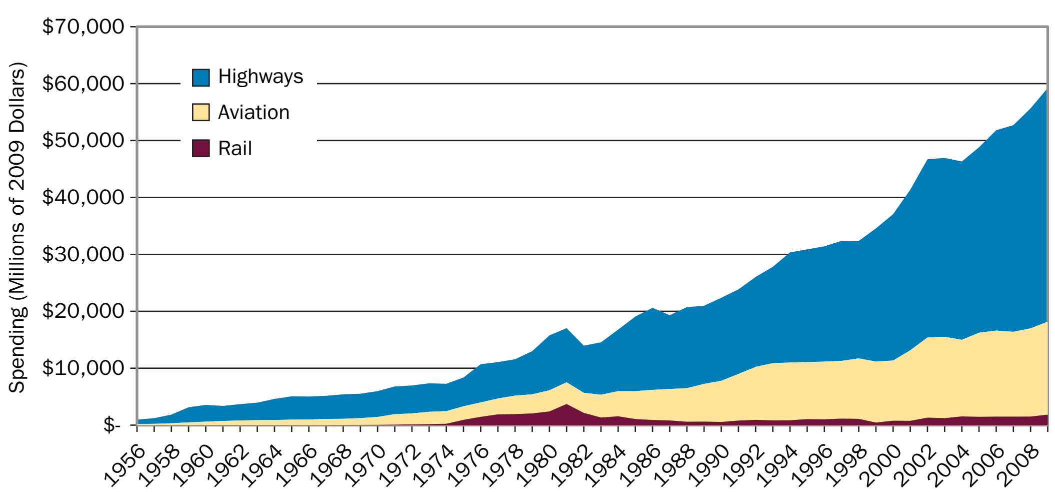
Significant investments in the U.S. Interstate Highway System since the 1950s initially produced excess surface transportation capacity, but congestion is now common on many highway sections, particularly in and around major metropolitan areas. The federal government has also subsidized the aviation industry, but has lacked a comparable federal commitment to funding passenger rail infrastructure (figure 1). Such funding has been a precondition for bringing large rail capital projects to fruition in every other country where they exist.

At least 19 countries around the world are building or planning new high-speed rail lines (UIC 2011). China has invested several hundred billion dollars in building the world's most extensive high-speed rail system by 2012 (Bradsher 2010). Several oil- and gas-producing states in the Middle East are planning to spend billions of dollars on high-speed rail systems linking that region *(Independent Online* 2011). In Saudi Arabia, construction has already begun on a 276-mile high-speed rail line connecting the Islamic holy cities of Medina and Mecca via Jeddah, and the French engineering group Alstom has announced preliminary plans to build a high-speed rail line connecting Baghdad and Basra in Iraq (*Telegraph* 2011). Within the European Union system Spain is constructing some 1,500 miles of high-speed rail lines, France is planning more than 2,500 miles of new high-speed rail lines, and England has proposed the second phase of its national high-speed rail network.

The United States has been slow to invest in high-speed rail, but planning and policy making are now being pursued more seriously. In 2009 and 2010, the U.S. Congress appropriated $10.1 billion toward a new, competitive grant program for high-speed rail, and President Barack Obama's 2012 budget proposal assigns $53 billion over the following six years to begin developing a national high-speed and conventional passenger rail network that could connect up to 80 percent of Americans.

Broad support for the program across the country is evident in the 39 states that applied for funding since 2009, yet that support is not universal. Some critics have

FIGURE 1
Total Federal Spending on Highways, Aviation, and Rail, 1956–2009



Data Source: Congressional Budget Office (2010).

labeled it wasteful, lacking focus, or failing to aim for "true" high-speed technology (Laing 2011a). The fledging program has experienced its share of growing pains because the recent $10.1 billion infusion has required simultaneous planning, policy making, and grant administration by the U.S. Department of Transportation Federal Railroad Administration (FRA). The agency has adapted quickly, but these tasks are far outside FRA's traditional role of enforcing safety regulations on America's railroads.

To build and sustain support for a long-term commitment to develop a national high-speed rail network in America, proponents will need to lay out a compelling case for its benefits, particularly those related to U.S. travel behaviors, land use patterns, and urban and regional economies. Chapter 2 outlines potential benefits based on the experiences of other countries in building and operating high-speed rail systems since the 1960s, and the following sections introduce some characteristics of high-speed rail.

WHAT IS HIGH-SPEED RAIL?

The term *high-speed rail* refers to a variety of modern railway technologies that allow passenger trains to reach higher velocities than conventional trains. Due to advanced signaling systems, these high-speed trains can also operate with greater frequency, thus creating greater capacity to move more passengers. However, high-speed rail is more than just upgraded tracks and new trains. It is a complex system of rail operations and maintenance technologies and procedures, commercial and management policies and approaches, and innovative financing sources and mechanisms. Each component of this system contributes to high-speed rail's utility and competitiveness (UIC 2010a).

How fast is high-speed rail? The internationally recognized definition of high-speed refers to rail operations at or above 155 miles per hour (mph). In 1996 the European Union (EU) officially adopted Directive 96/48, which defines high-speed rail as trains capable of reaching speeds of 155 mph on dedicated, high-speed tracks or 125 mph on conventional tracks. As of January 2011, trains in 11 countries already operate at speeds up to 185 mph, and several can reach 215 mph—the current international standard for new lines. The world's fastest passenger train in commercial operation, in Shanghai, China, reaches top speeds of 260 mph using magnetic levitation technology (Givoni 2006; UIC 2011).

Major Operational Models

Over the last half century, four different operational models of high-speed rail have emerged, consisting of various combinations of new train and track technology (Campos and de Rus 2009; UIC 2010c).

1. Dedicated: The world's first operational high-speed rail model is Japan's *Shinkansen* ("new trunk line"), which has separate high-speed tracks that serve high-speed trains exclusively. The system was developed because the existing rail network was heavily congested with conventional passenger and freight trains and the track gauge did not support the new high-speed trains.

2. Mixed high-speed: Exemplified by France's *TGV* (*Train à Grande Vitesse*), this model includes both dedicated, high-speed tracks that serve only high-speed trains and upgraded, conventional tracks that serve both high-speed and conventional trains.

3. Mixed conventional: Spain's *AVE (Alta Velocidad Espanola)* has dedicated, high-speed, standard-gauge tracks that serve both high-speed and conventional trains equipped with a gauge-changing system, and conventional, nonstandard gauge tracks that serve only conventional trains.

4. Fully mixed: In this model, exemplified by Germany's ICE (Inter-City Express),

© ISTOCKPHOTO/OLLO

The third generation of Germany's ICE high-speed trains can reach speeds of 190 miles per hour. This train is traveling on the Frankfurt—Cologne Line.

most of the tracks are compatible with all high-speed, conventional passenger, and freight trains.

New Technologies

Two of the most notable high-speed rail technologies developed over the last few decades are known as a tilting mechanism and magnetic levitation (maglev).

In regions where high-speed trains must run on the conventional rail network, sharp curves can create centrifugal forces that cause significant discomfort to passengers. To solve this problem, rail engineers developed a mechanism that counteracts these forces by slightly tilting the trains as they slow down to enter the curves. Many Swedish and Italian high-speed trains, as well as Amtrak's Acela Express and Cascades services, use this tilting technology while running on conventional tracks. This alternative avoids the high costs of constructing new, dedicated high-speed tracks in areas without sufficient demand to justify such an investment (Givoni 2006).

Maglev technology is completely different from traditional steel-wheel-on-steel-rail technology. It involves using an electromagnetic force stored in very powerful magnets embedded in the guideways and underbody of the trains that cause the train to hover and propel it forward at extremely high velocities. Test maglev trains in Japan have achieved speeds over 360 mph (Takagi 2005). This dedicated track technology means that maglev trains are incompatible with other passenger and freight rail tracks, and conventional and freight trains are incompatible with the maglev guideways. China is currently the only country with an existing maglev train in commercial operation (Givoni 2006).

HIGH-SPEED RAIL'S TRACK RECORD

High-speed rail is hardly a new transport technology. Japan has been the global pioneer since 1964, when the *Shinkansen* Tokaido line opened as the world's first high-speed rail service. It had an initial speed of

"Transport technologies seldom make a comeback, save in nostalgia trips for well-heeled tourists. . . . But there is a spectacular exception: railways, written off thirty years ago as a Victorian anachronism destined to atrophy before the steady growth of motorway traffic, have suddenly become one of the basic technologies of the twenty-first century. The reason of course is the high-speed train." — Banister and Hall (1993, 157)

130 mph, but the maximum speed has risen to 168 mph, bringing Tokyo and Osaka within a three-hour rail journey of each other (JR Central 2011c). The Tokaido line has served more than 5 billion passengers and is by far the world's busiest high-speed rail line (*Envoy Media* 2010). Thus, 1964 marked the beginning of what Banister and Hall (1993) term the world's *second railway age*.

High-speed rail did not catch on right away, however. It was not until 1981 that France introduced its *TGV Sud-Est* line, Europe's first high-speed rail line, connecting Paris with Lyon, France's second largest urban area. Operating at a speed of 168 mph, the line reduced travel time to two hours for the 280-mile journey. France was able to lower construction costs by adopting a mixed high-speed rail system that utilizes conventional tracks on the approaches to main stations to avoid major disruptions due to construction and unnecessary scarring of the urban fabric (Chen and Hall 2011). Italy was the only other country to develop high-speed rail in the 1980s.

In 1991, Germany's *Deutsche Bahn* opened its first Inter-City Express (ICE) service between Hamburg and Munich via Frankfurt. Originally the system was designed to be fully compatible for passenger and freight trains, but this model has shifted in favor of segments with limited or no freight service, including those from Cologne to Frankfurt and from Cologne to Berlin via Hannover (Chen and Hall 2011). Spain's *Alta Velocidad Española* (*AVE*) line between Madrid and Seville began running in 1992 at speeds of 199 mph. The only other country to construct a high-speed rail service in the 1990s was Belgium, which connected Brussels to London and Paris in 1997 via the Eurostar system (UIC 2011).

Since 2000, high-speed rail service has been introduced in England, South Korea, Switzerland, Taiwan, The Netherlands, Turkey, and the United States. The eighth and by far most notable recent entry into high-speed rail is China, which opened its first high-speed rail line in 2003. Shortly thereafter it had already built the world's most extensive high-speed rail network. According to the International Union of Railways (UIC 2011), by January 2011 China had opened 3,914 miles of high-speed rail (nearly 40 percent of the world total), had over 2,696 miles under construction, and was planning another 1,802 miles (table 1).

High-speed trains wait at the South Railway Station in Beijing, China.

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PROSPECTS FOR A U.S. SYSTEM

High-speed rail in the United States is a story that, until recently, has been limited to the Northeast Corridor, where Amtrak

TABLE 1
High-Speed Rail in Operation and Under Construction Worldwide

	In Operation				Under Construction			Total		
Country	First year of operation	Miles	Percent of Total	Top Speed (mph)	Miles	Percent of Total	Top Speed (mph)	Miles	Percent of Total	Annual Ridership
China	2003	3,914	37.2	220	2,696	55.9	220	6,610	43.1	290,540,000
Japan	1964	1,655	15.7	190	235	4.9	230	1,890	12.3	288,836,000
Spain	1992	1,278	12.2	190	1,098	22.7	190	2,376	15.5	28,751,000
France	1981	1,178	11.2	200	130	2.7	200	1,309	8.5	114,395,000
Germany	1991	798	7.6	190	235	4.9	190	1,033	6.7	73,709,000
Italy	1981	574	5.5	190	—		—	574	3.7	33,377,000
South Korea	2004	256	2.4	190	116	2.4	190	372	2.4	37,477,000
USA	2000	362	2.1	150	—		—	362	1.5	3,200,000
Taiwan	2007	214	2.0	190	—		—	214	1.4	32,349,000
Turkey	2009	146	1.4	160	317	6.6	160	463	3.0	942,000
Belgium	1997	130	1.2	190	—		—	130	0.8	9,561,000
The Netherlands	2009	75	0.7	190	—		—	75	0.5	6,005,000
United Kingdom	2003	70	0.7	190	—		—	70	0.5	9,220,000
World Total	—	10,513	100.0	—	4,827	100.0	—	15,340	100.0	928,362,000

Notes: Data is sorted by miles in operation. China's annual ridership is an estimate based on various news reports. USA's annual ridership reflects FY 2010 ridership on Amtrak's Acela Express service on the Northeast Corridor.

Source: UIC (2011; 2009).

began operating the Acela Express service in 2000. Its trains reach top speeds of 150 mph and average around 75 mph. Federal investments being made in the south end of the corridor, where trains average 86 mph, will soon bring top speeds to 160 mph. The Northeast Corridor is the country's largest segment of publicly owned passenger rail infrastructure, which has contributed to its relative success. Most other passenger rail services nationwide operate on tracks owned by private freight railroads. The challenges of balancing freight and passenger operations in a single corridor restrict the ability to develop passenger rail speed, frequency, and reliability.

Despite a history of disinvestment in rail passenger service by previous administrations and Congresses, the Obama administration is now moving ahead to build and improve conventional passenger rail service and develop selected high-speed rail corridors simultaneously. Most other countries historically have built and improved their conventional rail networks over decades and then made the leap to dedicated, high-speed corridors as the conventional lines reached capacity and required upgrades. In contrast, the case of California represents a leap from minimal existing passenger rail service today to a statewide high-speed rail system, similar to new corridor investments in Spain and China.

Project Grants and Tiers of Service

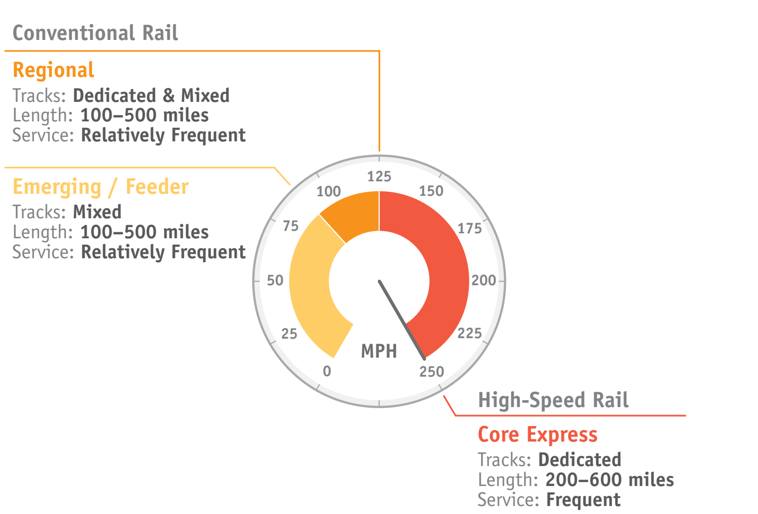
In 2009, the Obama administration launched the High-Speed Intercity Passenger Rail (HSIPR) Program, a competitive grant program that makes awards around the country for projects that seek to develop dedicated high-speed rail corridors and increase speeds, frequency, and reliability on existing rail lines.

In awarding the projects, the FRA developed a new definition that distinguishes three tiers of high-speed and intercity passenger rail service, which differ somewhat from international definitions of high-speed rail (figure 2). The top tier U.S. service, termed Core Express, operates at speeds above 125 and up to 250 mph on dedicated tracks.

According to the U.S. Department of Transportation, the "FRA's vision for a national high-speed rail program is to develop tiered passenger rail corridors that take into account the different markets and geographic contexts found throughout the United States" (U.S. DOT 2010, 10). This is consistent with the recommendation in this report that investments in Core Express corridors be directed toward the largest markets in the country, where population density and congestion on competing modes of transportation justify the level of investment in dedicated high-speed rail. Lesser investments in Regional or Emerging/Feeder corridors could serve smaller networks of metropolitan regions and emerging markets, using an incremental approach to making improvements over time.

Under these definitions, the planned California high-speed rail system is the only project awarded a federal grant to date that is designed to be a Core Express service with top speeds of 220 mph on new, dedicated tracks. The existing Acela Express service in the Northeast Corridor currently meets the FRA's definition of Regional service, though plans for the Northeast Corridor would bring the service up to Core Express (see chapter 5). Most other passenger rail services operating on freight rights-of-way in the United States fall into the category of Emerging/Feeder service.

FIGURE 2
U.S. Definitions of High-Speed and Intercity Passenger Rail Corridors



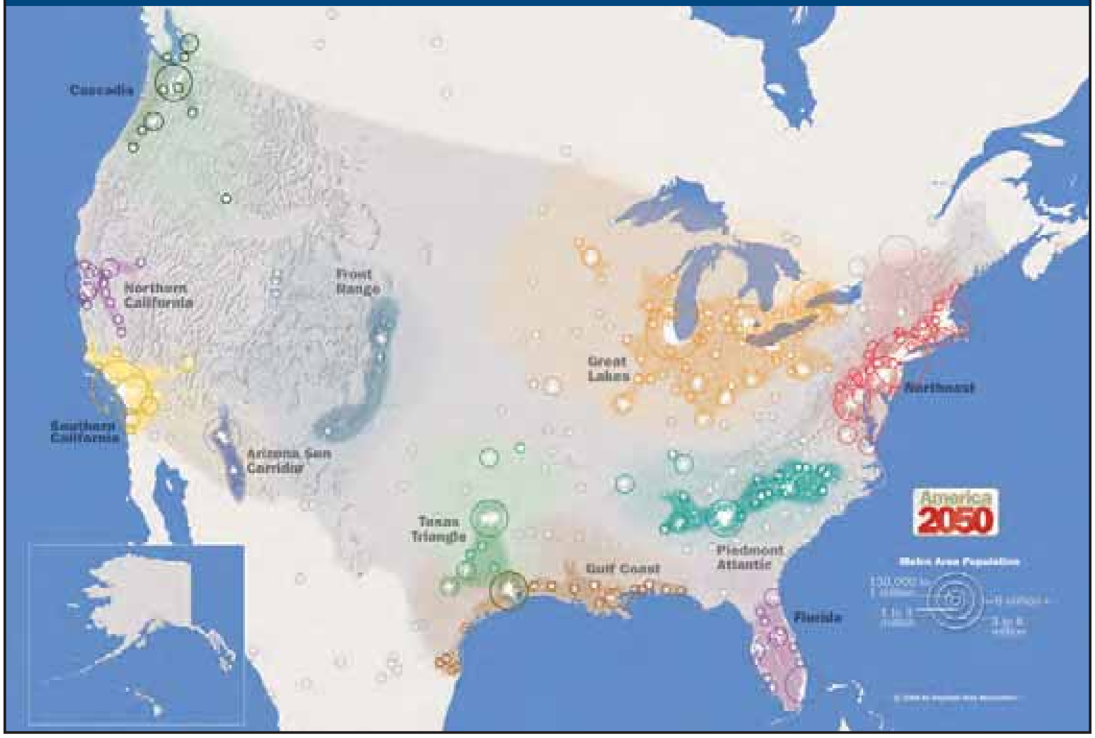
Data source: U.S. DOT (2010).

Shared Passenger and Freight Corridors

While Core Express corridors are expensive to plan and construct, they avoid conflicts with freight operations and allow trains to run at top speeds. Conventional, shared passenger rail corridors face the challenge of balancing passenger and freight service on tracks owned primarily by private freight railroads. Some freight railroads have raised concerns about expanding passenger rail service on their networks, fearing it will limit their ability to expand freight operations in the future (Levitz 2010).

The American Association of Railroads (AAR), the industry organization for North American railroads, has developed principles to balance passenger and freight needs on shared corridors. They focus on safety, access, and capacity; full compensation to freight railroads; and adequate liability protection (AAR 2011). While the association has not specified a preferred speed limit for passenger trains on freight railroads, it notes

FIGURE 3
Megaregions of the United States



Source: America 2050 (2008).

that at higher speeds passenger trains should operate on separate tracks from freight trains. The speed at which passenger trains can travel on freight-owned tracks has been a sticking point in negotiations between states and railroads, with differing views over whether 79, 90, or 110 mph should be the limit for passenger trains on shared corridors (Levitz 2010).

Focus on Megaregions

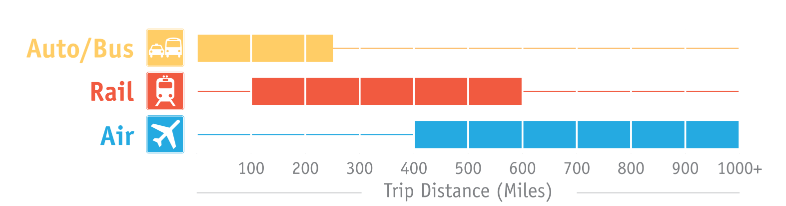
The factors conducive to high-speed rail ridership, such as population density and congestion on competing modes of travel, are found primarily in 11 large megaregions that contain 75 percent of America's population and jobs (figure 3). In the most recent draft of the National Rail Plan, the U.S. Department of Transportation highlights the growing population, road congestion, and air congestion in U.S. megaregions as important challenges that could be addressed by investments in passenger and freight rail (U.S. DOT 2010).

Megaregions are large networks of metropolitan areas linked by overlapping commuting patterns and business travel, economic activity, urbanization, and cultural resources. They stretch over hundreds of miles with populations of greater than 10 million people (America 2050 2008). They provide an ideal setting for high-speed rail networks because they concentrate multiple metropolitan areas and their central business districts within corridors or networks of 100 to 600 miles (America 2050 2011). As figure 4 illustrates, this is the distance at which high-speed rail trips are more time- and cost-effective than trips by automobile or airplane (Steer Davies Gleave 2004).

Sir Peter Hall (2011, 352) has recently commented favorably on the potential

FIGURE 4

The Best Transportation Mode for Different Trip Distances



Source: Prepared by the authors.

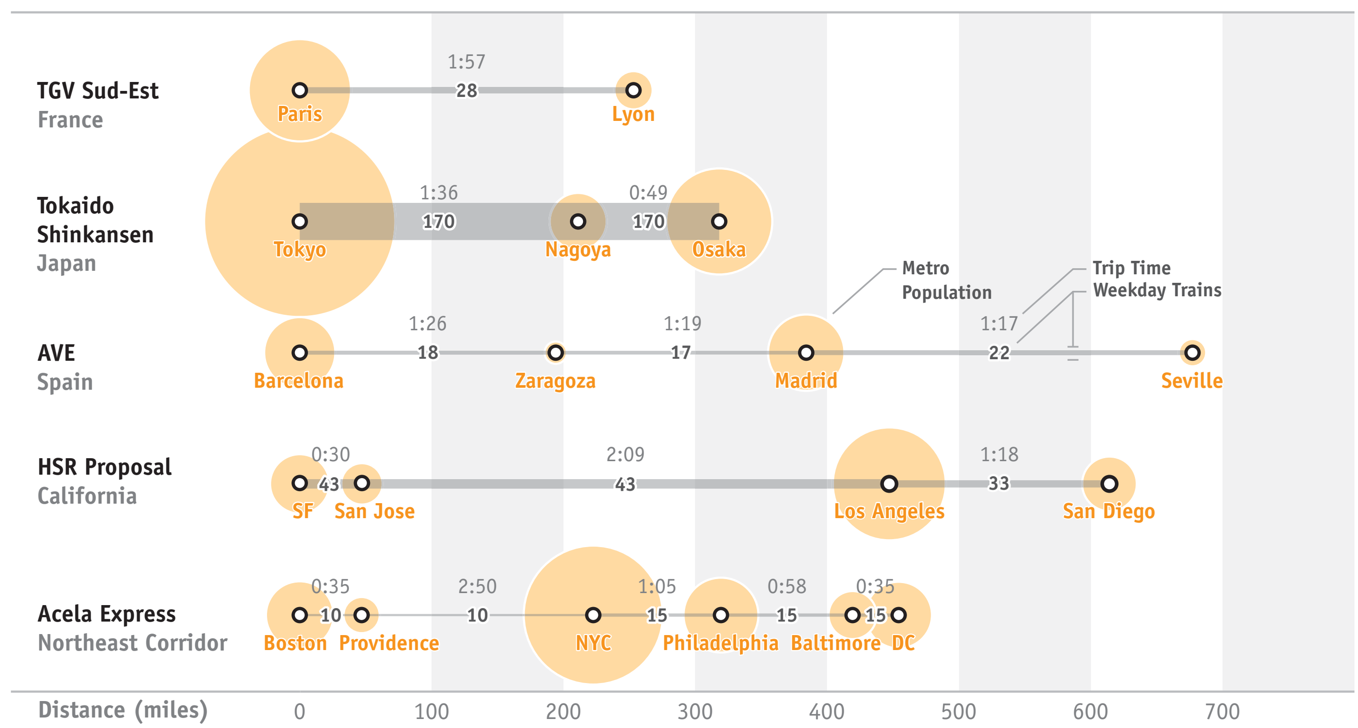
for high-speed rail in the California and Northeast Megaregions, although he is less sanguine about the megaregions further from the coasts.

> *[T]he spatial scale of these regions is ideally suited to HSR as a competitor to air, with the major cities spaced along linear corridors over distances up to 500 miles, served by some of the world's most trafficked (and hence most-profitable) short haul air corridors. Elsewhere—first in Japan and now in Europe—HSR has quickly seized the lion's share of traffic along analogous corridors: Tokyo-Nagoya-Osaka, Paris-Lyon-Marseille, London-Manchester, Paris-Brussels-Amsterdam and Madrid-Zaragoza-Barcelona. There is no reason to believe that the result will be different on corridors such as Washington-New York-Boston or San Francisco-Los Angeles.* (Hall 2011, 352)

Many U.S. megaregions, including those in California, the Northeast, the Midwest, Cascadia, and Texas, contain corridors of comparable length and connect metropolitan regions comparable in size to successful high-speed rail corridors around the world (figure 5). The distances between urban centers in these corridors are also long enough for trains to reach high speeds, making

FIGURE 5

Comparison of International High-Speed Rail Corridors to California and the Northeast



Source: Prepared by the authors.

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them time-competitive with other modes. For example, to reach 200 mph, high-speed trains require about 16 miles of straight and flat track to accelerate (Amtrak 2010a). High-speed trains also need significant distances to brake and come to a stop, so stations must be well-spaced along high-speed rail corridors to maximize reductions in travel time.

As envisioned by the FRA, a national passenger rail network would be built around investments in high-speed, high-capacity Core Express corridors that connect major metropolitan centers in the nation's megaregions and are fed by Regional and Emerging/Feeder service on routes collecting passengers from smaller markets (U.S. DOT 2010). For distances greater than 600 miles, the aviation system will continue to provide the most cost-effective and energy-efficient transportation options between megaregions and to more remote places.

Decisions about where to invest in Core Express corridors versus Regional and Emerging/Feeder services will require a more robust planning and decision-making framework at the federal level than has been possible to date. Recent research by America 2050 (2011) provides a potential starting point for understanding which rail corridors may justify different levels of investment and service. That study rated potential existing rail corridors nationwide on a scale of 0 to 21 based on factors contributing to rail ridership demand, such as population density, employment concentrations, transit connections, existing air markets, and congestion on parallel road corridors (figure 6). A similar approach should be adopted by federal decision makers to prioritize investments in high-speed rail corridors, combined with a study of construction and operating costs for each corridor.

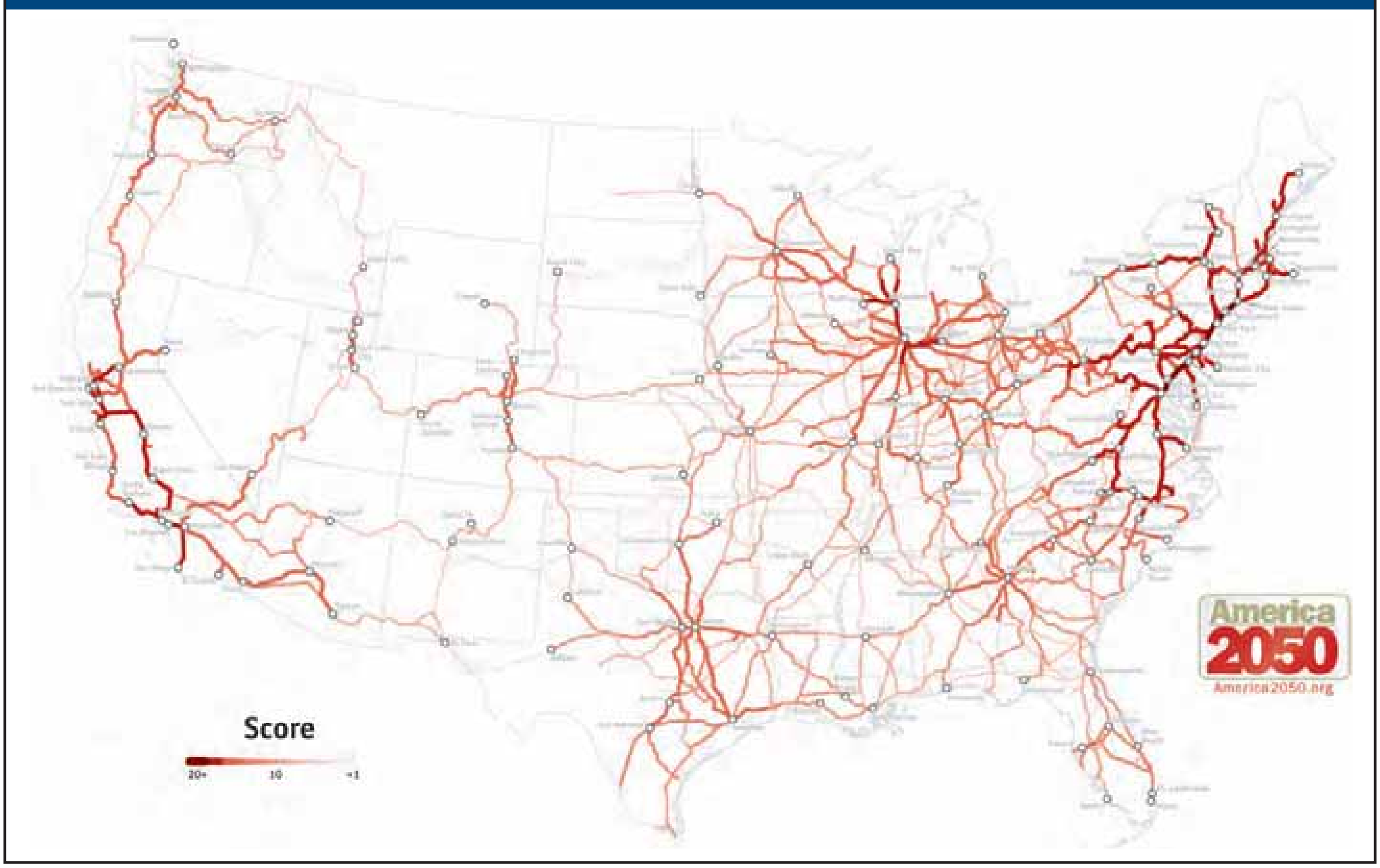
High-speed rail is envisioned to connect America's largest metropolitan areas, such as Chicago, with other cities up to 600 miles away.

SUMMARY

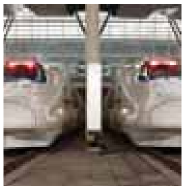
High-speed rail has a history of providing safe, efficient, and rapid ground transportation for more than four decades, and it currently operates in more than a dozen countries around the world. A variety of operational models are in use, from dedicated tracks for high-speed trains to tracks shared by high-speed and conventional passenger trains. In general, high-speed trains tend to serve trip distances of 100 to 600 miles, the distance at which fast trains can compete for market share with automobiles and airplanes.

The United States has only recently begun to support high-speed rail through a competitive grant program for which the FRA has defined three levels of passenger rail service: high-speed, dedicated Core Express service; Regional service on shared tracks; and Emerging/Feeder service that supports smaller and emerging markets. This range of service types reflects the variety of development patterns and markets across the United States. Core Express is the only service that meets the international definition of high-speed rail, and currently it is being pursued only in California. It would connect two megaregions where such service is likely to be successful due to the concentrations of population and economic activity.

FIGURE 6
Relative Market Demand of Potential Passenger Rail Corridors in the United States



Source: America 2050 (2011).



CHAPTER 2

Potential Benefits of High-Speed Rail

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Nearly a half-century of international experience with high-speed rail has proven that it is capable of producing a wide range of transportation, economic, and environmental benefits. Every potential high-speed rail corridor requires unique considerations and treatments, based on the characteristics of the megaregion it serves and the metropolitan regional planning context of each station along the route. This chapter outlines the range of benefits that high-speed rail can offer, and suggests how to maximize them.

TRANSPORTATION BENEFITS

High-speed rail is first and foremost a transportation improvement that provides a framework for other secondary benefits.

Shorter travel times: High-speed rail can create travel time savings for those who would have used a different mode of transportation between urban centers. It improves overall access to many destinations in the megaregion and brings those places closer together, a phenomenon referred to as the "shrinking continent" (Spiekermann and Wegener 1994).

High-speed rail offers an alternative to congested highways in California.

Mode shift: Where it is competitive with other intercity transportation modes, high-speed rail can capture a large share of passenger volume. International experience suggests that high-speed rail usually captures 80 percent of air or rail trips, if the travel time by high-speed train is less than two and a half hours (UIC 2010a). Mode shift to rail provides the greatest benefit in regions where road and air capacity is constrained.

Safety: High-speed rail systems around the world have experienced excellent safety records. Until a deadly accident in China in July 2011, high-speed rail operations on dedicated tracks had never experienced a single injury or fatality (UIC 2010b). If high-speed rail is built in the United States and meets historic safety standards, one result could be fewer transport-related deaths as more passengers choose rail for intercity travel.

Reliability: Dedicated high-speed rail services usually operate at greater frequencies than conventional rail, and have fewer delays and better on-time performance than cars and airplanes. The average delay of a *Shinkansen* train on the Tokaido line is only 30 seconds (JR Central 2011b). Spain's *AVE* provides a full refund to passengers if their train is more than five minutes late (RENFE 2011).

Capacity: By adding capacity to the railway network, high-speed rail can divert a large share of passenger rail service to new, dedicated tracks, thus freeing up capacity on the conventional rail network for freight and other intercity and commuter rail services. For example, the United Kingdom has chosen to address capacity constraints on its West Coast Main Line with the implementation of the proposed High Speed 2 (HS2) line. In Japan, the main motivation for implementing the Tokaido line between Tokyo and Osaka was to provide additional capacity to the transportation network, rather than to reduce travel times (Givoni 2006).

Efficient land use: A typical high-speed rail line has the ability to transport approximately the same number of people in the same direction as a three-lane highway, but on a fraction of the land area. The right-of-way width of a typical two-track high-speed rail line is about 82 feet—one-third the width of a standard six-lane highway (246 feet). This difference in land use amounts to a savings of 24.3 acres per mile of high-speed rail. Such a savings could be particularly significant in environmentally sensitive areas that need protection and in urbanized areas where land for highway expansion is costly to acquire (UIC 2010a).

ECONOMIC BENEFITS

High-speed rail's ability to promote economic growth is grounded in its capacity to increase access to markets and exert positive effects on the spatial distribution of economic activity (Redding and Sturm 2008). Transportation networks increase market access, and economic development is more likely to occur in places with more and better transportation infrastructure. In theory, by improving access to urban markets, high-speed rail increases employment, wages, and productivity; encourages agglomeration; and boosts regional and local economies. Empirical evidence of high-speed rail's impact around the world tends to support the following theoretical arguments for high-speed rail's economic benefits.

Higher wages and productivity: The time savings and increased mobility offered by high-speed rail enables workers in the service sector and in information-exchange industries to move about the megaregion more freely and reduces the costs of face-to-face communication. This enhanced connectivity boosts worker productivity and business competitiveness, leading to higher wages (Greengauge 21 2010).

Deeper labor and employment markets: By connecting more communities to other population and job centers, high-speed rail expands the overall commuter shed of the megaregion. The deepened labor markets give employers access to larger pools of skilled workers, employees access to more employment options, and workers access to more and cheaper housing options outside of expensive city centers (Stolarick, Swain, and Adleraim 2010).

Expanded tourism and visitor spending: Just as airports bring visitors and their spending power into the local economy, high-speed rail stations attract new tourists and business travelers who might not have made the trip otherwise. A study by the U.S. Conference of Mayors (2010) concluded that building high-speed rail would increase visitor spending annually by roughly $225 million in the Orlando region, $360 million in metropolitan Los Angeles, $50 million in the Chicago area, and $100 million in Greater Albany, New York.

Direct job creation: High-speed rail creates thousands of construction-related jobs in design, engineering, planning, and construction, as well as jobs in ongoing maintenance and operations. In Spain, the expansion of the high-speed *AVE* system from Malaga to Seville is predicted to create 30,000 construction jobs (*Euro Weekly* 2010). In China, over 100,000 construction workers were involved in building the high-speed rail line that connects Beijing and Shanghai (Bradsher 2010). Sustained investment could foster the development of new manufacturing industries for rail cars and other equipment, and generate large amounts of related employment.

Urban regeneration and station area development: High-speed rail can generate growth in real estate markets and anchor investment in commercial and residential developments around train stations, especially when they are built in coordination with a broader set of public interventions and urban design strategies (see chapter 3). These interventions ensure that high-speed rail is integrated into the urban and regional fabric, which in turn ensures the highest level of ridership and economic activity. For example, the city of Lille, France, experienced greater than average growth and substantial office and hotel development after its high-speed rail station was built at the crossroads of lines linking London, Paris, and Brussels (Nuworsoo and Deakin 2009).

Spatial agglomeration: High-speed rail enhances agglomeration economies by creating greater proximity between business locations through shrinking time distances, especially when the locations are within the rail-friendly 100 to 600 mile range. Agglomeration economies occur when firms benefit from locating close to other complementary firms and make use of the accessibility to varied activities and pools of skilled labor.

The high-speed train station and surrounding development in Lille, France.

High-speed rail has also been described as altering the economic geography of megaregions. By effectively bringing economic agents closer together, high-speed rail can create new linkages among firms, suppliers, employees, and consumers that, over time, foster spatial concentration within regions (Ahlfeldt and Feddersen 2010). This interactive process creates net economic gains in addition to the other economic benefits described here.

A case study in Germany (box 1) exemplifies increased economic benefits associated with high-speed rail, but in other cases the results have fallen short of expectations. This mixed evidence underscores the importance of ensuring that transportation connections, station locations, urban development, and promotional strategies are in place to maximize the economic impact of this capital-intensive investment.

BOX 1

Economic Benefits of High-Speed Rail in Montabaur and Limburg, Germany

In 2002 a new dedicated high-speed rail line in Germany between Frankfurt and Cologne connected the country's two largest regional economies and its busiest airport. Trains on the line travel at speeds over 185 mph, reducing the travel time between the two cities by 74 minutes and bringing total travel time to less than an hour along the 110-mile route. The new line has five stations, including those in the rural towns of Montabaur and Limburg (figure 7). Locating stations in these towns was controversial, due to their small potential markets. The towns have 12,500 and 34,000 residents, respectively, and are only about 12 miles apart, limiting the trains' ability to maintain maximum speeds.

A study by Ahlfeldt and Feddersen (2010) was able to isolate the effect of the rail stations on the two small cities because they are in peripheral locations and had negligible economic growth prior to the construction of the stations. Any increase in economic development could be measured easily and could be assumed to be exogenous to the towns' natural growth paths. Furthermore, the decision to locate the stations in these two towns was driven mainly by politics; in other words, it was a discretionary decision and the situation is replicable.

The researchers found that the areas surrounding the new stations experienced a 2.7 percent annual increase in overall economic activity compared with the rest of the region, and that this growth was persistent. They concluded that the economic gains experienced in these two towns were due to the introduction of the high-speed rail service, which increased accessibility to the regional markets of Frankfurt and Cologne. The service helped Montabaur and Limburg attract new residents, which increased the local employment pools and consumer markets, and eventually attracted new businesses that helped to drive the towns' growth. The study notes that the political leadership of these towns helped to ensure this growth by securing developable land close to the new high-speed rail stations.

FIGURE 7

Montabaur and Limburg Stations in the German ICE Rail Network

Source: Prepared by the authors.

ENVIRONMENTAL BENEFITS

High-speed rail has the potential to provide greater environmental benefits and energy efficiencies than other modes of long distance travel. However, several conditions must be met to obtain these benefits.

Energy efficiency and ridership: High-speed rail offers greater operating efficiency on a per passenger mile basis than competing modes, such as single-occupancy automobiles or airplanes that require significant amounts of fuel to get off the ground. For example, *Shinkansen* trains are estimated to use one-quarter the energy of airplanes and one-sixth that of private automobiles per passenger mile (JR Central 2011a).

To achieve environmental benefits, high-speed trains must maximize load factors to realize the greatest efficiencies. As high-speed rail ridership increases, so does its relative energy efficiency, whereas a high-speed train carrying no passengers ceases to be efficient in any sense.

In regions where the number of total trips is not growing, high-speed rail can bring about a net reduction of energy use through mode shift by capturing passengers from automobile or airplane trips. In regions like California where population and trips are projected to keep growing, high-speed rail can help reduce the energy and climate impacts on a per passenger basis through a combination of mode shift and attracting new passengers to high-speed rail.

Energy mix: High-speed rail is the only available mode of long-distance travel that currently is not dependent on motor fuels. High-speed rail is powered by electricity, which is not without environmental problems depending on its source (see table 2). If it is powered by electricity generated from fossil fuels, such as coal or natural gas that discharge harmful greenhouse gas emissions, then its environmental benefits are limited. However, electricity is generally considered an improvement over petroleum-

A bullet train leaves Tokyo Station near the Shiodome skyscrapers.

TABLE 2
Origins of Electricity Used by European Railways in 2005

Member State	Solid Fuels	Oil	Gas	Nuclear	Renewable
Belgium	12%	2%	25%	58%	3%
Germany	54%	0%	8%	27%	11%
Spain	38%	4%	18%	22%	18%
France	5%	2%	3%	86%	5%
Italy	34%	10%	42%	0%	15%
United Kingdom	37%	1%	37%	20%	5%

Source: IFEU (2008).

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Passengers boarding a Thalys international high-speed train at Gare du Nord, Paris.

generated power and provides a crucial advantage as the United States aims to reduce its dependence on foreign oil. Amtrak's Northeast Corridor and parts of the Keystone Corridor (connecting Harrisburg, Pennsylvania to Philadelphia) are electrified. Most other conventional passenger trains in America operate on freight rail lines and are powered by diesel fuel.

Energy planning needs to be a part of the planning for high-speed rail to ensure the reduction of greenhouse gases and other harmful pollutants. Even with the current energy mix that includes fossil fuel sources, however, high-speed rail can yield significant environmental benefits. A recent study by the University of Pennsylvania (2011) found that a new high-speed line in the Northeast Corridor, powered by electricity from the current energy mix, would divert nearly 30 million riders from cars and planes, attract 6 million new riders, and still reduce car emissions of carbon monoxide by more than 3 million tons annually. The system would also result in a reduction of carbon dioxide emissions if the energy mix were shifted to low carbon emitting sources.

Nuclear power is a significant source of electricity for passenger rail in countries such as Belgium, France, Germany, and Spain. France is by far the largest nuclear power user, with a share of more than 85 percent for railway operations. However, growing concerns about nuclear power following the 2011 Fukushima Daiichi plant accident in Japan raise doubts about its role in the development of a U.S. high-speed rail system in the near future. Spain's rail network uses renewable energy sources for 18.4 percent of its electricity (IFEU 2008). Japan's high-speed rail uses geothermal and hydro power to meet up to 56 percent of its energy needs (Tan 2011).

Technological innovation: The energy efficiency of different models of high-speed trains also varies considerably. With all other factors being equal, increases in a train's speed require proportional increases in the amount of energy needed to propel it, compared to a conventional passenger train.

Designing trains to be lighter in weight and more aerodynamic can offset these energy requirements.

For example, the energy efficiency of Japan's *Shinkansen* trains has improved over time. Current models use nearly one-third less energy than those introduced in the mid-1960s, and they travel significantly faster. This energy savings was achieved, in part, by switching from a concentrated traction system to a distributed traction system. The latter system replaces trains using a single locomotive with trains that have powered axles on every passenger car. This change lightens the axle load, increases the reliability of operations, and lessens the impact on the track. These factors have encouraged other nations such as France and Germany to make similar transitions in rolling stock technology (JORSA 2008).

U.S. regulations requiring crashworthiness of passenger trains present a challenge for high-speed trains to achieve better aerodynamics and lighter weight. Federal rail safety regulations traditionally have required that passenger and commuter trains be built to withstand a collision with a freight train. The 2008 head-on collision in Los Angeles between a Metrolink commuter train and a freight train occurred because a train operator did not see a red stop signal. The accident killed 25 people, demonstrating the serious risk of this type of incident.

European and Japanese guidelines for high-speed trains take a completely different approach, focusing on crash avoidance and providing strict physical or time separation between passenger and freight trains and other system safety precautions. Crash avoidance systems are seen as the preferred approach to safety and are utilized successfully in high-speed rail systems around the world (AHSRA 2011a).

The California accident led to the passage of the U.S. Rail Safety Improvement Act of 2008, which requires all passenger trains and certain freight trains to have advanced train control technologies on board by 2015 (Hymon 2008). This new feature ensures that trains remain separated by a safe distance and automatically applies the brakes if trains get too close to each other.

The FRA has acknowledged that high-speed trains operating on dedicated tracks with train control systems in place do not require the same crashworthiness standards as a conventional train on a freight network. Recently, FRA officials have indicated a willingness to update their rules to reflect a "system safety" approach, which focuses more on crash avoidance than crashworthiness. However, before changing nationwide safety standards to accommodate high-speed trains, the agency has indicated it will consider issuing waivers on a case-by-case basis, such as for the California system, in which trains will continue to operate on tracks with conventional passenger trains in certain segments, though not with freight trains (U.S. DOT 2009b).

SUMMARY

High-speed rail provides a range of potential transportation benefits, including greater speed, safety, frequency, and reliability of ground transportation, and brings cities and their regions closer together by shrinking time distances and effectively increasing access to markets. This increased access expands economic productivity and labor markets, with benefits for businesses and workers, and promotes spatial agglomeration of businesses in related industries. High-speed rail can also boost tourism and visitor spending, and when coordinated with other strategies it can promote urban regeneration. The environmental benefits of high-speed rail depend on several conditions: strong ridership, clean energy sources to power trains, and mode shift from less efficient forms of transportation.

CHAPTER 3

U.S. Policy and Programs for High-Speed Rail Investment

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The Susquehanna River Bridge between Perryville and Havre de Grace in Maryland was built in 1906. It is just one of Amtrak's older bridges in the Northeast Corridor that need to be replaced.

Each country that has developed high-speed rail has done so with strong national government leadership. Prior to President Barack Obama's recent embrace of high-speed rail, federal government support had been a missing ingredient in U.S. passenger rail development. However, significant federal investments in high-speed rail in 2009–2010 put the federal High-Speed Intercity Passenger Rail (HSIPR) Program on a solid initial footing. Whether that commitment can be sustained in a difficult fiscal environment will determine whether high-speed rail in the United States can become a reality.

The federal commitment to high-speed rail began in 2008, when Congress passed the Passenger Rail Investment Improvement Act (PRIIA), which authorized funding for Amtrak and state-led efforts to develop high-speed rail corridors between 2009 and 2013. In February 2009, just months after PRIIA was signed into law at the end of 2008, the act became the vehicle for appropriating $8 billion for high-speed rail under the American Recovery and Reinvestment Act (ARRA). An additional $2.5 billion for high-speed rail was appropriated by Congress in the Fiscal Year (FY) 2010 budget (figure 8).

These appropriations, totaling $10.5 billion for high-speed and passenger rail, transformed the preservation-focused program established by PRIIA into a highly visible high-speed rail initiative that later became the centerpiece of the Obama administration's infrastructure agenda.

However, this sudden infusion of funding also revealed PRIIA's limitations and the challenges of creating an ambitious high-speed and intercity passenger rail program virtually overnight.

The subsequent Congressional appropriation for FY 2011 stripped the program of any funding in 2011 and rescinded $400 million from the FY 2010 budget. This abrupt reversal underscores the program's vulnerability to shifting political winds as long as it has to rely on annual Congressional appropriations for its funding.

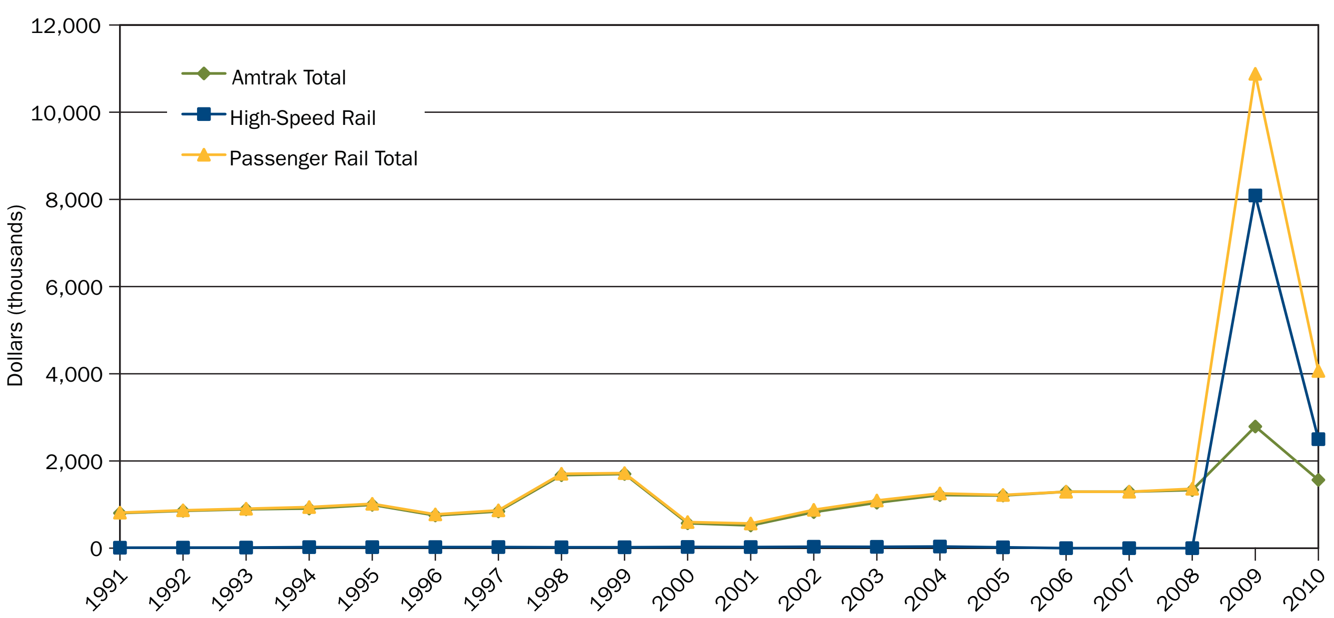
THE CURRENT LEGISLATIVE AND FUNDING FRAMEWORK

The current federal policy framework for high-speed rail was shaped in response to both the history of unreliable and minimal federal contributions for passenger rail and the efforts of individual states acting on their own initiative and with their own funding to improve rail corridors. While PRIIA is an improvement over the previous lack of a U.S. passenger rail policy, it is not well-suited to a more ambitious, sustained federal commitment to building dedicated, multistate high-speed rail corridors.

Unlike the U.S. highway and transit programs, which rely on dedicated revenue streams from the federal motor fuels tax, passenger rail has no dedicated source of revenue and thus relies on Congress for general fund appropriations. Prior to the passage of PRIIA, most passenger rail appropriations were made directly to Amtrak each year, but with no multiyear authorization since 2002. Numerous Amtrak officials have testified to Congress over the years that the uncertainty of these annual, often politicized, appropriations makes planning and operating the railroad difficult.

In the absence of consistent federal support for passenger rail, states including

FIGURE 8
U.S. Funding of Passenger and High-Speed Rail, 1991–2010



Note: Dollars not adjusted for inflation.

Source: National Association of Railroad Passengers (2008).

California, North Carolina, Pennsylvania, and Washington have established dedicated funding streams to improve conventional passenger rail corridors operated by Amtrak. Other states, such as Illinois, Maine, and Vermont, have directed state general funds or flexible federal funds to subsidize and supplement their passenger rail service (U.S. GAO 2010).

These state investments have led to the purchase of new rail cars in Washington, track upgrades for and re-electrification of the Keystone Corridor in Pennsylvania, and more frequent, reliable service and higher ridership on all state-sponsored lines. State funding for rail has come from various sources, including portions of state gas and diesel taxes, flexible funding from the federal Congestion Mitigation and Air Quality Improvement Program, state rental car taxes, and proceeds from specially branded Cash Train scratch lottery tickets in Washington state.

THE HIGH-SPEED INTERCITY PASSENGER RAIL PROGRAM

In recognition of these and other state initiatives, PRIIA established a competitive federal grant program to assist the states and Amtrak in making capital improvements to existing passenger rail corridors that could enhance service, relieve congestion, and develop new high-speed rail services on either existing or new rights-of-way (table 3). These statutes provide the basis for the HSIPR Program, administered by the U.S. Department of Transportation.

The program began in June 2009 with an announcement of funding availability and interim guidelines (U.S. GAO 2011). The FRA was charged with administering the program, selecting applicants, awarding grants, negotiating funding agreements, and writing a national passenger and freight rail plan. These new responsibilities required the FRA to increase its planning staff quickly, since most of its existing employees were focused on the traditional roles of the agency—safety and regulatory enforcement of freight and passenger rail services.

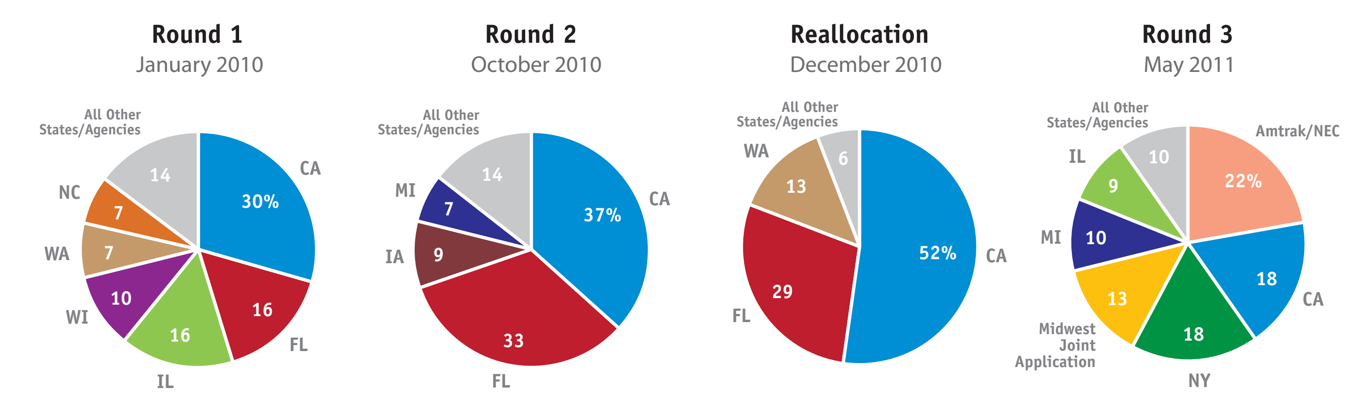
The HSIPR Program has three funding categories to which states, groups of states, interstate compacts, public agencies, or Amtrak are eligible to apply. One of the programs, the High-Speed Rail Corridor Development Program, is restricted to the 11 federally designated high-speed rail corridors, although grants can be obtained through the other two funding categories for projects on other corridors.

TABLE 3
Federal Statutes Created by the Passenger Rail Investment Improvement Act of 2008

PRIIA Statute (2008)	Eligibility	Purpose
Intercity Passenger Rail Corridor Capital Assistance (Sec. 301)	States, groups of states, interstate compacts, and public agency rail operators	Capital costs of facilities, infrastructure, and equipment
High-Speed Rail Corridor Development (Sec. 501)	States, groups of states, an interstate compact, public agency rail operators, or Amtrak, for federally designated high-speed rail corridors	Broadly defined capital projects to acquire, construct, and improve rail structures and equipment. High-speed rail is defined to include service reaching operating speeds of at least 110 miles per hour. The project must be included in a state rail plan. (An exemption was made to this requirement in PRIIA.)
Congestion Relief (Sec. 302)	States and Amtrak	Projects to reduce congestion or facilitate ridership growth in heavily traveled rail corridors and projects identified by the Surface Transportation Board to improve on-time performance and reliability

Source: U.S. DOT (2009a).

FIGURE 9
HSIPR Program Awards by State



Source: U.S. DOT (2011d and 2011e).

The sudden $10.1 billion in funding for high-speed rail in ARRA and the FY 2010 budget was welcomed with great enthusiasm by states nationwide, 39 of which applied for rail planning or construction grants. But it required a rapid increase in capacity at the federal level and within state transportation departments to administer and participate in the program. This new program relied on the states to submit applications for eligible projects. Given the previous lack of federal commitment to passenger rail, only a few states had staff capacity for rail planning or the expertise to develop proposals for Core Express high-speed rail. States with previous commitments to rail planning and funding generally were able to put together successful proposals in the 2009 and 2010 rounds of grant making (figure 9).

The two states that had already developed plans for Core Express high-speed rail were the most successful in the competition for federal funding. California voters had passed a $9 billion bond act in 2008 to fund a Core Express high-speed rail project connecting Northern and Southern California, and the state was awarded federal grants of approximately $3.6 billion. Florida, which was able to resubmit its high-speed rail proposal from the 2000s, was awarded a total of $2.4 billion for the initial Tampa–Orlando segment of the statewide high-speed rail project. However, this project was cancelled in early 2011 by newly elected Governor Rick Scott. The remaining federal grant awards went to conventional rail projects, such as those in Washington and Illinois, for projects to increase the speed, reliability, and frequency of passenger rail services on shared passenger and freight corridors.

By mid-2011, the distribution of grants largely reflected the status of rail planning efforts across the country, with some attention to geographic equity. The FRA's grantmaking process was criticized for a lack of transparency by Chairman John Mica of the House Transportation and Infrastructure Committee. However, a U.S. Government Accountability Office (GAO) report that he commissioned states: "The FRA established a fair and objective approach for distributing these funds and substantially followed recommended discretional grant award practices used throughout the government" (U.S. GAO 2011, 22).

By August 2011, two years after the launch of the HSIPR Program, nearly 75 percent of the awarded funds had been released to 25 states, the District of Columbia, and Amtrak, allowing them to start work. However, the program continues to face criticisms, largely focused on the perceived high cost of rail investments; unimpressive trip time savings; and the lengthy timeline for rail planning, engineering, environmental review, and construction.

FEDERAL RAIL POLICY CHALLENGES

Even though PRIIA is authorized through 2013, stakeholders in the rail industry, including one of the drafters of PRIIA, have remarked on the need to adjust federal rail policy to respond to current circumstances, including greater political instability in the Middle East and its implications for America's dependence on foreign oil; growing international and private sector interest in helping to finance high-speed rail in the United States; and the president's own ambitious proposals for a national high-speed rail network to give 80 percent of Americans access to high-speed rail over the next 25 years (Gardner 2011).

Such a vision requires a stronger and more active federal commitment that must start with secure funding. The most recent setback of zero funding for high-speed rail in the FY 2011 budget underscores the need for a sustainable revenue source as reliable as funding for highway and transit programs in the past. President Obama's proposal to include a $53 billion, six-year high-speed rail program as part of the surface transportation bill would help to achieve this kind of equity among transportation modes.

In conjunction with a funding strategy, the role of high-speed rail in America's larger transportation network needs to be better defined (U.S. GAO 2009). A sharper, more narrowly focused program directed at corridors that meet clearly articulated objectives for high-speed rail service would address criticisms that the program is diffuse, ineffective, and dependent on ongoing subsidies. Nationally available data could help to evaluate the most promising regions for attracting ridership and enhancing economic and other benefits. A phasing plan and funding allocation strategy could help develop the full build-out of a national network by helping states secure rights-of-way for high-speed rail corridors.

Another challenge is to clarify the differences between conventional and high-speed rail corridors. PRIIA provides federal grants for both conventional passenger rail and new high-speed corridors, although the media has tended to focus on the high-speed program. Neither PRIIA nor ARRA specified the share of federal funding to be used for high-speed Core Express corridors versus conventional passenger rail. In fact, the dearth of high-speed rail projects in the planning pipeline means that grants will be shared among various types of rail projects.

A more active role by the federal government could help clarify the respective roles of high-speed Core Express corridors and conventional Regional and Emerging/Feeder routes, including funding them through separate programs and clearly defining the objectives for each type of rail service. Funding for maintaining and upgrading existing rail corridors could be provided through formula funds based on passenger train movements, track miles, or ridership. President Obama's FY 2012 budget proposal for the Department of Transportation moved in this direction by establishing different competitive grant programs, including network development for constructing new corridors and system preservation for maintaining safety and reliability on existing corridors (White House 2011).

The national high-speed rail program also must overcome a lack of effective

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institutions and administrative structures for building and operating multistate corridors. Public benefit corporations capable of entering into public-private partnerships could develop and maintain high-speed rail infrastructure across megaregional, multistate, and even binational territories. These corporations would be responsible for the tracks, while separate public and private entities would operate the trains. Federal legislation could be developed to enable the creation of these public infrastructure corporations.

International examples of publicly chartered infrastructure corporations include the High Speed 1 (HS1) and High Speed 2 (HS2) companies in the United Kingdom, Spain's state-owned Administrator of Railway Infrastructures (Adif), and *Réseau Ferré de France (RFF)*, the French Rail Network. Regional public benefit corporations could be created in the United States to develop and manage track infrastructure, receive federal high-speed rail grants, and enter into contracts with private consortia for design, construction, and maintenance.

SUMMARY

The PRIIA legislation enacted in 2008 provided a transition from an era with no federal partner for high-speed and passenger rail to a period of active federal partnership with the states. Thirty-two states, the District of Columbia, and Amtrak have been awarded funding through the HSIPR Program and are moving ahead to plan or build high-speed and conventional rail projects. Given the quick start-up nature of the program, the FRA did an admirable job of responding to many simultaneous new duties, but also faced challenges in both laying the groundwork for a foundational program and implementing it at the same time.

The setbacks experienced in 2011, when several governors cancelled rail projects and Congress appropriated zero dollars for high-speed rail, provide an impetus to reset the program in a way that will better position it for long-term success. Federal policy initiatives could set the program on firmer footing for a long-term commitment and restore public confidence in an era of fiscal austerity.

CHAPTER 4

Station Location and Design: A Typology and Case Studies

The potential of high-speed rail to promote urban regeneration in conjunction with new or enhanced rail stations is one of its most promising economic benefits (U.S. Conference of Mayors 2010). The experience with land development around high-speed rail stations has been mixed, but one thing is clear: high-speed rail cannot generate growth by itself. High-speed rail can play a prominent role in economic regeneration, but it is difficult to isolate its impacts from other complementary actions that are necessary to stimulate a larger economic development success story (Givoni 2006).

To take advantage of high-speed rail's potential land development benefits, cities must adopt policies and planning strategies that encourage station-related development and undertake careful planning of the track routing, station location, and intermodal transportation connections. Significant land development effects have been documented more frequently in places with robust regional economies and linkages with other transportation modes, especially rail transit links to nearby urban centers, and places with public sector support for policies that encourage development (Sands 1993; Greengauge 21 2006).

High-speed rail stations have been located in almost every setting—from the highest density centers of major cities to the most pastoral landscapes. In each case, the location reflects a complex interaction of physical, economic, logistical, and political considerations. Similarly, the designs of the stations illustrate rich variety, from the modernization and adaptive reuse of historic buildings to the construction of completely new, purpose-built structures.

It is difficult to generalize across all of these conditions, but existing European stations suggest a typological framework that may help to guide planning for high-speed rail in the United States (figures 10a and 10b). In particular, different station locations necessarily create a different dynamic between existing concentrations of activities and the increased access provided by high-speed rail.

Center-of-city stations can reinforce established concentrations of development. Their potential to spur further development is often magnified by the connectivity of the existing urban fabric and the extent of nearby transit connections.

Edge-of-city stations can alter the center of gravity of a city's core and spur redevelopment of underutilized areas at the urban periphery.

Suburban and exurban stations can create new centers that concentrate growth around the station or enable corridor development between the station and a nearby existing node. In some cases, such stations are located too far from the key regional destinations and fail to attract much ridership or spinoff development.

Special purpose stations can either retain their narrow function as intermodal facilities, such as airports, or can develop as mixed-use centers in themselves.

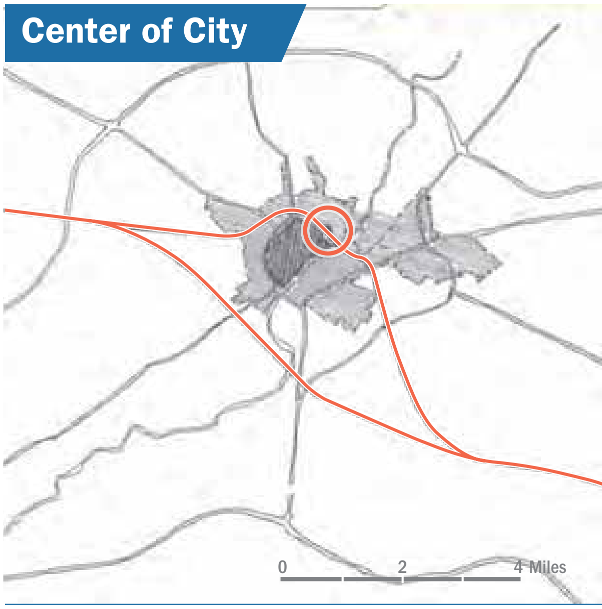
FOUR EUROPEAN STATIONS

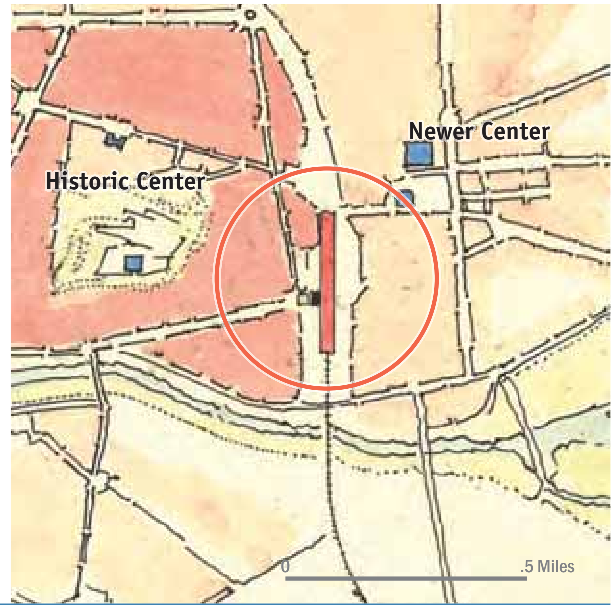
Center of City: Lleida Pirineus Station, Lleida, Spain

Lleida, with a city population of 137,000, is the capital of the province of Lleida in Spain's Catalan region. Surrounded largely by agricultural land, the nearest cities also served by high-speed rail are Zaragosa (700,000; 80 miles away), Huesca (52,000;

FIGURE 10A
Typology of High-Speed Rail Station Locations

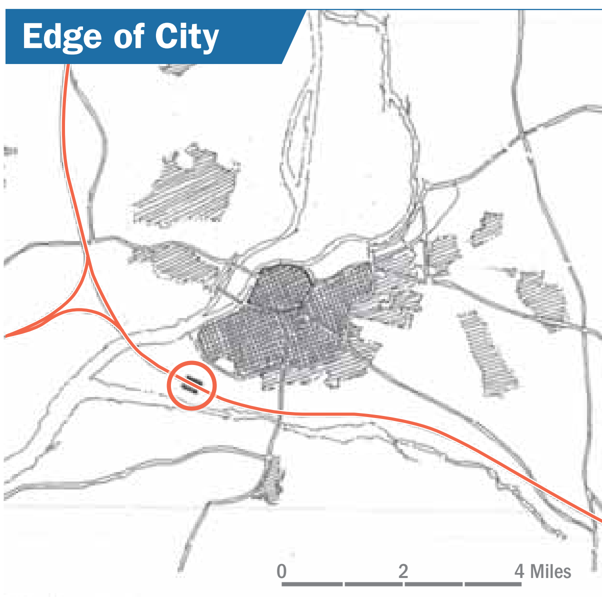
Center of City

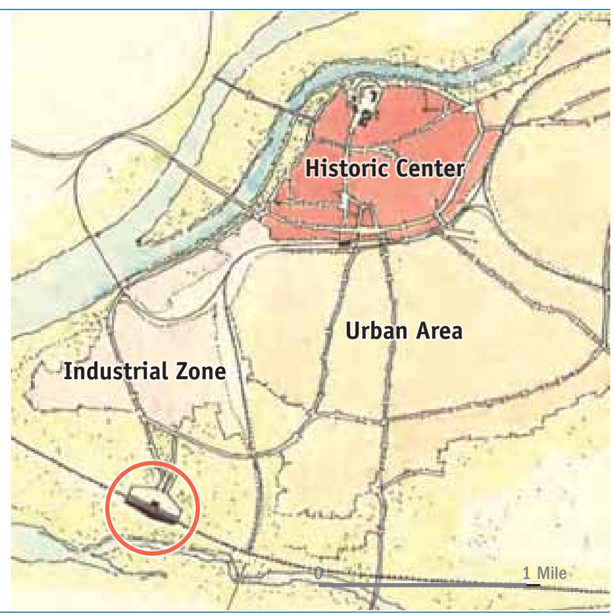




Lleida, Spain	Impact	Lessons Learned
City Population: **137,000** Metro Population: **250,000** Year Opened: **2003** Frequency of Service: **41 trains daily (in summer)** Distance to Major Destinations: **2 hours to Madrid; 1 hour to Barcelona**	Tourism grew 15 percent annually. Business conventions up 20 percent. New high-tech industrial park built nearby.	Supporting urban design interventions beyond the immediate station area leveraged the role of the station as a seam between older and newer parts of the center city.

Edge of City





Avignon, France	Impact	Lessons Learned
City Population: **95,000** Metro Population: **255,000** Year Opened: **2001** Frequency of Service: **65 trains daily (in summer)** Distance to Major Destinations: **2 hours 40 minutes to Paris; 1 hour to Lyon**	The economic development impacts are unclear at best. If anything, the historic center city station area may have declined.	Lack of integration with the historic center city, in part because of physical barriers, has created a competitive rather than complementary dynamic with the center city station area.

Prepared by the authors.

65 miles away), and Tarragona (155,000; 50 miles away).

This high-speed rail station is located north of the historic center, about a half-mile from the hilltop fortifications that mark the symbolic epicenter of the city. The station is on a loop of track that branches off another line that enables some high-speed trains to bypass the city center. The station is at a strategic point of transition between the older historic center to the south and newer districts to the north. As the tracks enter the city along its northern edge, they are covered by a boulevard lined with newer buildings. Several major streets radiate from the station area into the core of the city and into the areas to the north.

Connectivity: The station is well-connected to a variety of other transport modes, including the Catalan regional commuter rail service and local and regional buses. Long-range redevelopment plans call for expanding the commuter network and relocating the bus station to the train station area. While no major highways connect to the station directly, several multilane boulevards lead to surface parking lots around the station.

Economic development impacts: The area around the railway station is being rebuilt as part of a comprehensive plan that calls for approximately 980,000 square feet of commercial, retail, and entertainment space, as well as gardens, bridges, and parking. Since the high-speed rail service was initiated in 2003, tourist visitation has increased by about 15 percent and demand for business conventions has risen 20 percent each year (Burnett 2009). An example of collateral development outside the station area is a new high-tech industrial park established in 2005. High-speed rail is seen by the station developer as crucial to attracting companies such as Microsoft and Indra Software Labs, a Spanish information technology company.

Lessons learned: The Lleida station is an example of investment in high-speed rail to leverage not only the redevelopment of the immediate station area, but also a capital-intensive master plan to transform other nearby neighborhoods by taking

A bird's eye view of the high-speed rail station in Lleida, Spain.

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TGV Station in Avignon, France.

advantage of the station's strategic location between the older and newer parts of the city.

Edge of City: Avignon, France

The Avignon *TGV* station is on the Mediterranean high-speed rail line linking Paris, Lyon, and Marseille. While the region is heavily urbanized, it is still highly valued for its natural landscape qualities. Avignon, a city of 95,000, is one of several significant centers in Provence that are served by high-speed rail lines, including Orange (30,000; 15 miles away), Nimes (146,000; 25 miles away), and Aix-en-Provence (143,000; 50 miles away). Avignon is also linked to the major metropolitan areas of Montpellier (60 miles away) and Marseille (70 miles away).

The *TGV* station is located about two miles from the historic center of Avignon on a dedicated high-speed rail route that bypasses the city along its southern edge. This largely industrial district is surrounded on two sides by the Rhône River and is cut off from the rest of the city by rail lines and train yards. The area within a half-mile radius of the station is in a floodplain and thus consists of a designed landscape with a few buildings and access roads, but no regular street and block pattern.

Connectivity: The Avignon *TGV* station is served by high-speed rail, but lacks any direct connection to the nearby conventional rail services. Shuttle buses travel to the city center every 15 minutes, but most station visitors access the area by automobile using a network of roads that link nearby highways to 1,800 parking spaces in the station lots.

Economic development impacts: The economic development benefits of high-speed rail service for Avignon are unclear because development was never contemplated for the immediate station area. Rather, the station was always conceived as a signature, modern structure designed to reflect local environmental conditions and landscape design traditions. In terms of broader municipal impacts, the *TGV* station has become the primary gateway to the region at the expense of development activity around the conventional rail station in the city center.

Lessons learned: The Avignon *TGV* station exemplifies the limits of potential benefits of high-speed rail for several reasons: lack of interconnectivity with local and regional transportation networks; emergence of a competitive rather than synergistic dynamic between the old and new station areas; and an isolated setting that inhibits the integration of its new development with the existing urban fabric.

Exurban: Camp de Tarragona, Tarragona, Spain

The Camp de Tarragona high-speed rail station is located about 7 miles north of the city of Tarragona, an industrial center of 155,000 people with a university and a port on the Mediterranean. The high-speed rail network branches north to Lleida and south to Castellon de la Plana, but does not go into the center of the city. The nearest large city is Barcelona (1.6 million; 60 miles away).

The area between the station and the city of Tarragona is characterized by historic small towns, several new community developments, and scattered industrial estates in an otherwise agrarian landscape that forms an historic territory known as Camp de Tarragona. An amusement park and major tourist attraction, Port Aventura, is also located within a 25-minute drive. While the road network is fairly sparse, ready access to highways and the dispersed development pattern suggest that this area will continue to urbanize.

Connectivity: The Camp de Tarragona station is served exclusively by high-speed trains, but the larger Barcelona–Tarragona region is well-linked by local and express buses and conventional commuter rail services. Buses also link the station to the city center, but automobiles are the primary mode of access to the station and its 648 parking spaces.

Economic development impacts: Since the establishment of the EU in 1992, Tarragona and other mid-sized industrial centers have benefited from integration with the rest of Europe, enabling manufacturers to achieve new economies of scale, higher production standards, and access to larger markets (Hamilton and Rodriguez-Pose 2001). It is likely that the high-speed rail station has reinforced this trend and the

The Camp de Tarragona AVE Station is located 7 miles outside Tarragona, Spain.

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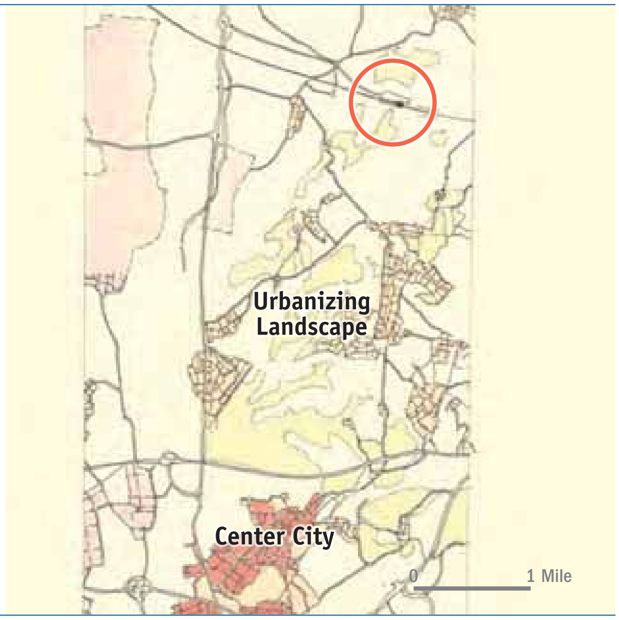
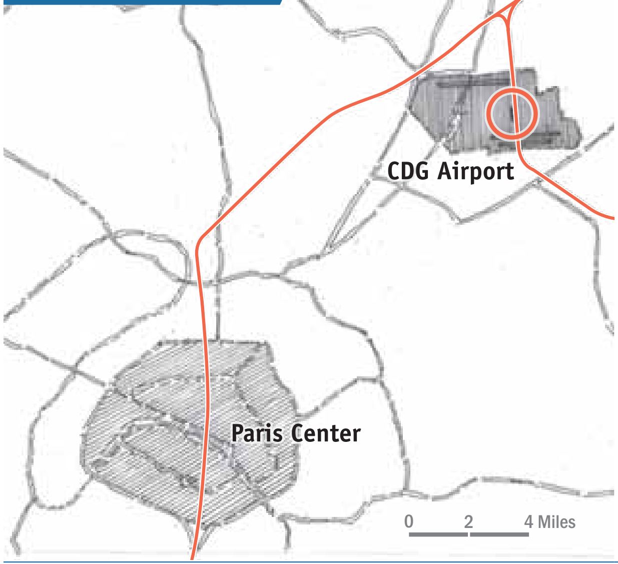
FIGURE 10B
Typology of High-Speed Rail Station Locations

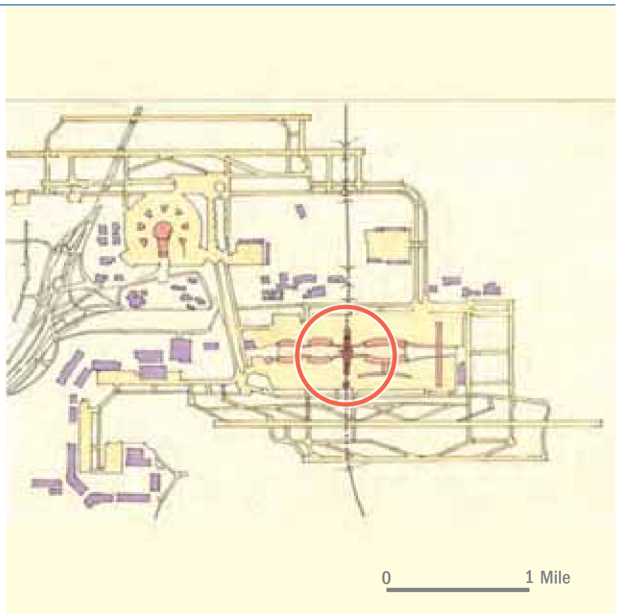
Exurban



Tarragona, Spain (Camp de Tarragona Station)	Impact	Lessons Learned
City Population: **155,000** Metro Population: **676,000** Year Opened: **2006** Frequency of Service: **46 trains daily (in summer)** Distance to Major Destinations: **2 hours 40 minutes to Madrid; 30 minutes to Barcelona**	High-speed rail connectivity with the rest of Europe has reinforced the role of Tarragona as a industrial center.	The city is already well-connected to metroplitan Barcelona. Given the cost of bringing high-speed rail into the center, the decision to locate the station in an outlying but urbanizing part of the landscape makes sense in this case.

Special Use





Roissy, France (Airport Charles de Gaulle)	Impact	Lessons Learned
City Population: **2,500** Metro Population: **11.8M** Year Opened: **1994** Frequency of Service: **79 trains daily (in summer)** Distance to Major Destinations: **22 miles to center of Paris; 2 hours to Lyon; 3 hours to Marseille**	Economic development impacts are difficult to determine.	The station successfully serves its purpose as an intermodal center and as such helps distribute the benefits of international air travel to a variety of provincial centers.

Prepared by the authors.

growing prosperity of the region through increased connectivity with other parts of Europe. The rail line also functions as a kind of high-speed commuter connection among regional capitals, including Tarragona, Lleida, Zaragoza, and Catalayud. However, it is difficult to disaggregate the marginal benefits of high-speed rail service in this dynamic area, especially since Tarragona is already well-connected to Barcelona by bus and conventional rail services.

Lessons learned: The Camp de Tarragona station is a case where high-speed rail serves a regional center that is already within the economic sphere of influence of a major metropolitan capital and well-connected by other means of transport. There was not a significant impact on tourism activity, due to the station's distance from the attractive areas on the coast. The cost of bringing the service to the center of the city may not have been justified because it would not have changed the fundamental dynamic between this city and other regional capitals.

Special Use: Airport Charles de Gaulle, Roissy, France

The Charles de Gaulle *TGV* Station (CDG *TGV*) is located within Charles de Gaulle Airport, about 22 miles from central Paris. The complex is located just beyond the urban edge of Paris and is surrounded by farmland, in addition to some airport-related commercial, logistic, and hotel development. The main economic activity of the area is generated from the airport and its associated offices, retail stores, and hotels. However, this activity is isolated, and there are few residents or businesses outside the airport site.

In contrast to the airport itself, CDG *TGV* is more oriented to France's provincial cities than to Paris. It is a stop along four different *TGV* lines that serve major destinations and regions throughout the country. Several of the *TGV* rail services that connect to CDG *TGV* intentionally bypass Paris, which is served by separate high-speed rail lines.

Connectivity: The station can be accessed only via the airport, and it was designed specifically to allow for intermodal transfers. The four-level structure is located within Terminal 2 and includes a variety of basic retail services. The *TGV* trains share this station with the suburban rail lines and buses that connect the airport with Paris. The station is fully integrated into the airport and is linked with the other terminals via a light-rail shuttle. There are about 11,000 parking spaces at Terminal 2, but they are shared with other airport users.

Economic development impacts: Because the station was constructed to connect the airport with cities throughout the country, it is difficult to assess the development impact of this high-speed rail service on the region. There is little development around the airport, and neither the airport nor the high-speed rail station is oriented toward the immediate surroundings. Additionally, it is hard to separate the economic impact of the *TGV* station from the airport itself, since the station supports and serves only CDG, which is the second busiest airport in Europe.

Lessons learned: High-speed rail is often seen as an alternative to air travel, but the network of high-speed rail lines that connect to the CDG *TGV* station complement airport service. The station has been successful in serving its purpose to provide greater access to France's busiest airport and to international flights for residents throughout the country, and it has done so without requiring a transfer flight through Paris for domestic passengers. This in turn has freed up air capacity at CDG for long-distance flights.

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TGV Station at Charles de Gaulle Airport in Roissy, France

TAKING ADVANTAGE OF REDEVELOPMENT OPPORTUNITIES

These case studies demonstrate that it is possible for any of the four station location types to create a redevelopment dynamic between the existing center and new activities. But these examples also support a principal finding of the literature: well-connected stations in center-city locations, when coupled with other investments, offer the greatest potential for urban revitalization (Ribalaygua and Garcia 2010).

Our analysis of aerial photos of 52 stations in Spain and France supports the finding that larger cities are more likely to bring high-speed rail service to stations in the city center than smaller cities with smaller markets and fewer resources (Facchinetti-Mannone 2009). The Tarragona case study suggests that center-city locations may not always be justified.

High-speed rail can alter the dynamic between a city and its larger neighboring economic hubs by shrinking the travel time between them and creating a shift in economic geography (Chen and Hall 2011). Lille, a city in the north of France, is cited frequently for its significant redevelopment activity after 1994, when a station opened on the new high-speed rail line connecting Paris to London or Brussels.

The Lille station, on the site of a former military barracks at the edge of the historic town center, was developed into a major mixed-use center, including offices, hotels, housing, a shopping center, a conference center with exhibition hall, and a public park. The high-speed rail station at the new rail junction for three major European capitals sparked a complete reorganization of land use and development in the city (Nuworsoo and Deakin 2009).

In declining neighborhoods and post-industrial areas, high-speed rail service can offer benefits by reactivating properties that previously had not attracted investment for redevelopment. New high-speed rail stations in these cases can bring economic vitality and redevelopment to land and historic structures that would otherwise remain idle (Bertolini and Spit 1998).

However, some new high-speed rail stations have not experienced appreciable economic effects. For example, *TGV* stations were located on the outskirts of the cities of Le Creusot and Haute Picardie to be more accessible by automobile. However, their remoteness and the dearth of existing business activity discouraged investment and failed to attract development to the area (Greengauge 21 2006).

Facchinetti-Mannone (2009) has observed that peripheral stations usually are not as well-integrated into the surrounding transportation networks or into the urban areas they serve. Attempts to mitigate this problem with shuttle services have been only moderately successful, since they still require an additional intermediary trip. The case of Avignon suggests that even when a peripheral station is close to the city center, the potential benefits of high-speed rail are diluted, and the new station instead may have negative impacts on the center-city station area because it creates a different competitive dynamic.

SUMMARY

Four European rail station case studies point to a variety of experiences with high-speed rail and development impacts. It is difficult to isolate and quantify the specific impacts of high-speed rail service alone because the most successful high-speed rail initiatives are part of larger urban redevelopment plans that include collateral investments and policies. However, it is clear that high-speed rail service in itself will not guarantee development around a station.

Center-city locations generally are more advantageous than peripheral sites, but the case studies reveal the degree to which the benefits of high-speed rail in any given location are moderated by the existing physical and economic circumstances. These observations can guide corridor and station location decisions in the United States and other countries contemplating the introduction of high-speed rail systems.

The North Railway Station in Valencia, Spain, is served by high-speed trains.

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CHAPTER 5

The Promise of High-Speed Rail in California and the Northeast Corridor

© CALIFORNIA HIGH-SPEED RAIL AUTHORITY

A high-speed train in the desert of California, as rendered by designers.

The government's tiered approach to passenger rail service reflects the vast diversity of spatial development patterns and markets for rail ridership across America. While some regions may not be positioned for high-speed rail today, the Northeast and California Megaregions have the population density, congestion, and projected growth that make investing in high-speed Core Express service most feasible.

California's 2009 population of 37 million is projected to grow by more than 25 million people by 2050 (State of California 2007). The Northeast Megaregion, with approximately 52 million people today, will add an additional 18 million by 2050 (Woods and Poole Economics 2010). On both coasts, major highways and airports are reaching capacity and creating a need for new and expanded transportation alternatives to satisfy demand for a growing number of intercity trips.

HIGH-SPEED RAIL PLANS IN CALIFORNIA

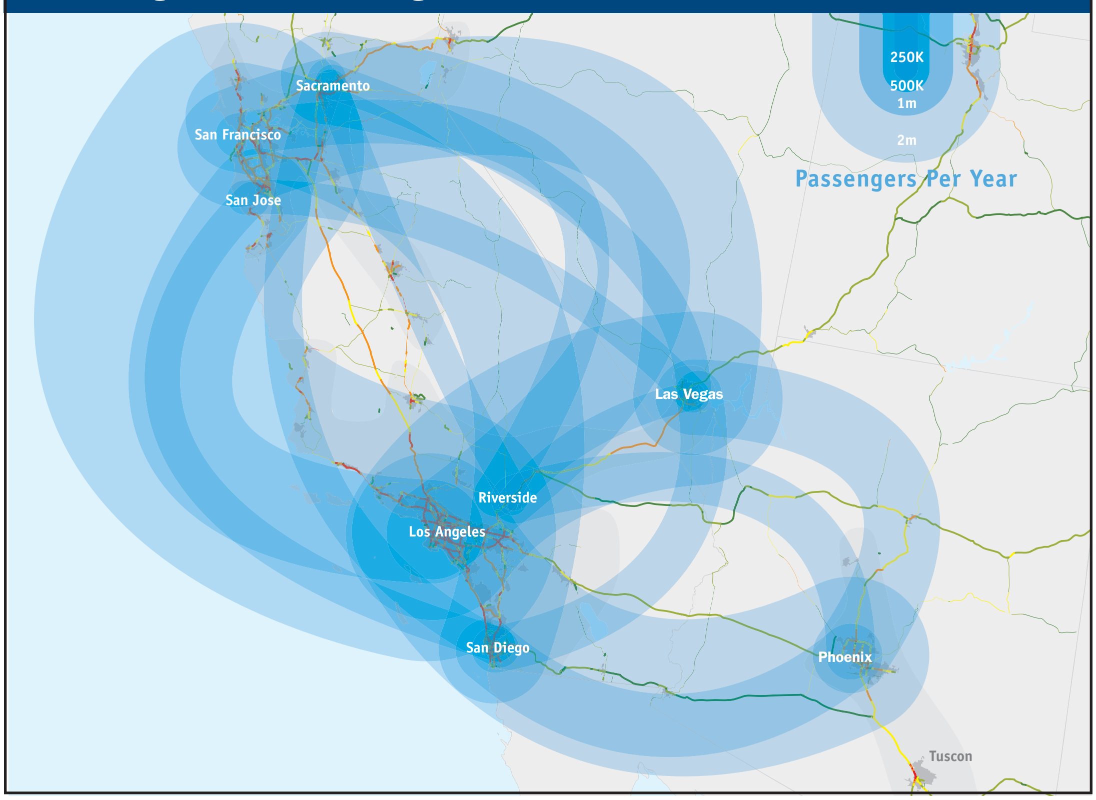
In 2008 California voters approved a bond act that will direct $9 billion toward building a statewide high-speed rail system. In making the case for the project, the California High-Speed Rail Authority (2010) estimated that to meet the same level of demand for intercity trips in the future, California would need to add roughly 3,000 highway lane miles and five new airport runways throughout the state, at twice the cost of high-speed rail investments.

As evidence of the demand for travel between northern and southern regions of the state, California has the largest short-haul air market in the nation, with approximately 3.14 million annual passengers between northern and southern California airports (figure 11). The state also suffers from some of the worst traffic congestion in the nation, particularly in and around its metropolitan areas. California already hosts the largest existing intercity rail market in the country outside the Northeast Corridor, with 2.6 million and 1.6 million annual passengers on the Pacific Surfliner Corridor and Capitol Corridor, respectively (Amtrak 2011d).

Construction of the first phase of an 800-mile high-speed rail system connecting San Francisco to Anaheim/Los Angeles is expected to start in fall 2012, at an estimated cost of $43 billion. Upon completion, the California system will operate trains at speeds up to 220 mph, reducing the travel time to 2 hours and 40 minutes for the 432-mile trip. In addition to the state bond act, the federal government has awarded California approximately $3.6 billion in high-speed rail grants. The state anticipates closing its funding gap with additional federal grants and financing through public- private partnerships.

As the only U.S. example of Core Express high-speed rail, the California project would, if fully realized, inspire confidence in America's high-speed rail program, while its failure would confirm skeptics' doubts. The project faces several challenges, the greatest obstacle being the state's significant budget deficit, estimated at approximately $20 billion annually through 2016 (California Legislative Analyst's Office 2010). This

Figure 11
Air Passengers on Short-Haul Flights in California and the Southwest



Source: America 2050 (2011)

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California's high-speed trains will serve Los Angeles's historic Union Station. Public authorities are purchasing the station along with 38 acres surrounding it in order to capture the value created by high-speed rail access.

situation could create competition between long-term high-speed rail investment and annual budget priorities, such as education, healthcare, and public employee pensions. California is also facing resistance to building rail infrastructure from local communities in densely populated areas, where new high-speed rail tracks may require elevated structures and increase visual or noise impacts.

Despite federal commitments of $3.6 billion to date, the uncertainty of future federal funding for the project is a variable over which the state has little control. The California rail authority's 2009 business plan estimates that approximately $17 to $19 billion of total project costs will be needed from the federal government. However, recent federal actions to defund the HSIPR Program, including the $400 million rescission in the FY 2011 budget, have raised doubts about whether the federal program will be able to meet California's future high-speed rail funding needs. California will have a difficult time convincing its own voters and state legislators to support continued state funding for the project until a stronger, multiyear federal commitment can be made.

CURRENT CONDITIONS IN THE NORTHEAST CORRIDOR

The 455-mile Northeast Corridor (NEC) between Boston and Washington, DC, is America's most intensively used rail line, and one of the most heavily traveled corridors in the world, carrying an estimated 260 million rail passengers per year. Eight different commuter railroads and Amtrak's intercity services share the corridor. Intercity rail passengers on Amtrak's Acela Express and Northeast Regional services account for approximately 13 million annual passengers, which is 45 percent of Amtrak's total U.S. intercity ridership (Amtrak 2010a; 2011a).

Demand for both commuter and intercity rail services on the corridor is expected to grow as gas prices rise and travelers seek transport alternatives to the automobile. Since November 2009, Amtrak has seen 20 consecutive months of ridership growth and is on pace to set an annual ridership record in 2011 (Amtrak 2011c). Amtrak anticipates that by 2030 ridership will grow 59 percent and train movements 38 percent on the Northeast Corridor (Amtrak 2010b).

Despite the Northeast Corridor's vital role in sustaining mobility in the Northeast Megaregion and supporting a robust intermodal transportation network, several issues undercut its potential for expansion (Amtrak 2010b).

- ***Condition:*** Although billions of dollars have been spent in recent years to improve the rail corridor, many long stretches have deficient or outmoded tracks, bridges, power, communications, and other systems that need to be upgraded. The whole corridor has an estimated backlog of $8.8 billion to achieve a state of good repair, and an additional $43.5 billion is needed to maintain facilities, replace aging assets, and expand the corridor's capacity and reliability through 2030 (Amtrak 2011b).
- ***Congestion:*** Several key segments of the corridor operate at 100 percent capacity. Minor operating problems often cause severe congestion and delays, and repairs on other segments of the corridor also cause backups throughout the system.
- ***Divided ownership and dispatching:*** While most of the corridor is owned by Amtrak, segments in Massachusetts, Connecticut, and New York are owned by those states' transportation departments. Trains dispatched from New Rochelle, New York, to New Haven, Connecticut, for example, are controlled by Metro-North Railroad, which prioritizes its commuter trains in this territory. As a result, Amtrak trains must operate at slower speeds in this segment of the corridor. In addition, agreements with the maritime community limit the number of Amtrak trains that can cross coastal bridges in Connecticut to 17 per day in each direction, or just over one train per hour (de Cerreño and Mathur 2006).

The Baltimore and Potomac Tunnel in Baltimore, Maryland, built in 1873, limits train speeds on this stretch of the Northeast Corridor to 30 mph, due to a sharp turn and steep grade.

© YOAV HAGLER

The Northeast Corridor rail network has evolved over 180 years, beginning in the 1830s, and much of the existing infrastructure was constructed by the Pennsylvania Railroad in the late nineteenth and early twentieth centuries. Key components of the early system included the Baltimore and Potomac Tunnel, the Hudson River tunnels, and Manhattan's Pennsylvania Station, completed in 1873, 1909, and 1910, respectively. The final section, including the Hell Gate Bridge and New York Connecting Railroad, was completed in 1917.

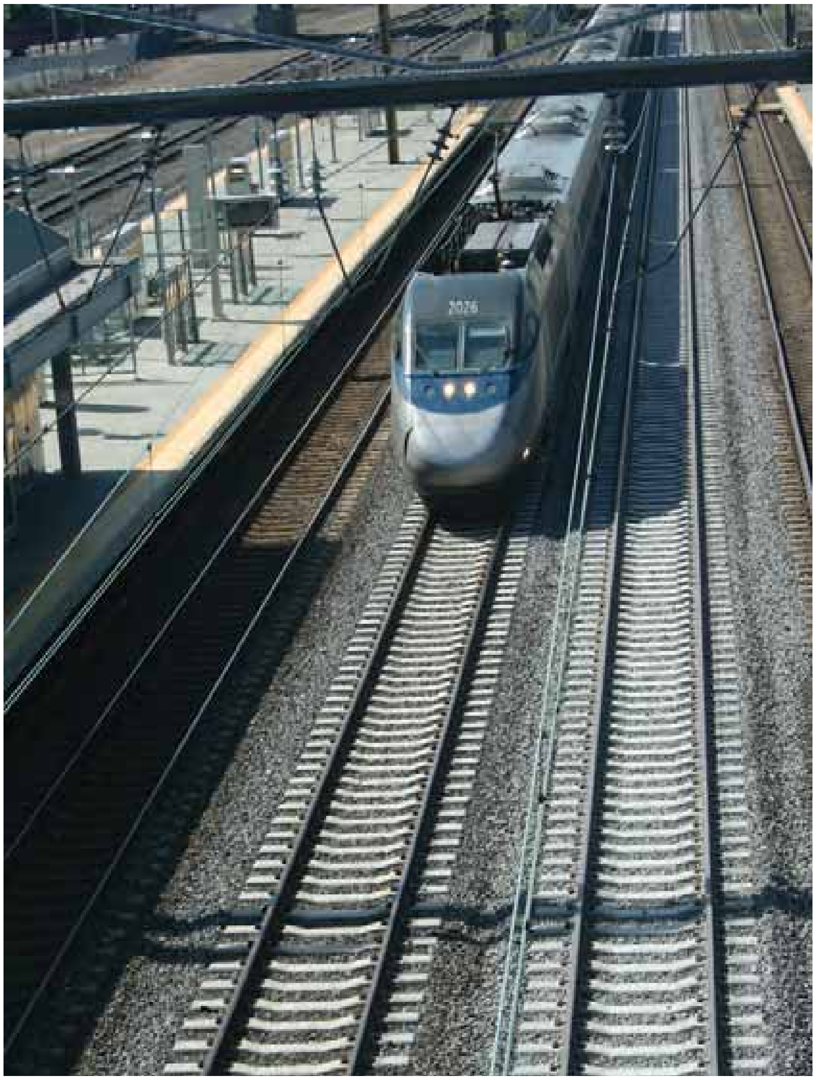
Most of the rail corridor is owned by Amtrak, a private corporation controlled by the federal government. Amtrak was established in 1971 after Penn Central, the last remaining passenger railroad company on the Northeast Corridor, went bankrupt and was forced to sell its assets. Amtrak acquired all of Penn Central's segments of the corridor that were not sold to public commuter transportation authorities, and it was also charged with providing intercity passenger service throughout the country.

In 1976 and again in 1992, Congress passed laws, including the Northeast Corridor Improvement Project (NECIP) and the Northeast High Speed Rail Improvement Program (NHRIP), which mandated Amtrak to reduce trip times on the corridor. Inspired by the success of high-speed rail services in Japan, France, and Spain, Congress appropriated billions of dollars to the Northeast Corridor for improvements that would set the stage for future high-speed rail service. Amtrak introduced Acela Express as a higher speed rail service in December 2000, but it has struggled to obtain enough funding for basic maintenance or capital investments to continue to improve trip times and reliability.

The Acela Express service reduced travel times between Boston and New York to about 3 hours and 30 minutes, and between New York and Washington to about 2 hours and 45 minutes. In 2010, Acela trains carried more than 3.2 million passengers and earned $450 million in ticket revenue, which more than covered its operating expenses (Amtrak 2011d, 96). Since 2001, Acela has provided more than 25 million passenger trips on the Northeast Corridor (Amtrak 2011a).

Lacking a dedicated track network, Acela trains must operate on congested tracks that also carry Northeast Regional service and eight different commuter rail lines. Accordingly, they have much lower rates of on-time performance and frequency compared with most high-speed rail systems around the world. For instance, Japan's *Tokaido Shinkansen* trains can carry more than 1,300 passengers while traveling at over 160 mph, operating on 5–10 minute headways, and keeping the average delay below 30 seconds (JR Central 2011b). By comparison, Acela trains can carry only 300 passengers while operating on 60 minute headways at average speeds of less than 80 mph with a 84.3 percent on-time performance (Railway Technology 2011; Amtrak 2011b).

Acela trains are capable of reaching top speeds of 150 mph, but they can reach this speed only on short segments of the corridor due to congestion and tight curves in the track alignment. The average speed of the Acela trains is 62 mph between New York



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An Acela train stops at the Newark Airport Station on the Northeast Corridor.

and Boston, and 86 mph between New York and Washington, DC.

New Visions for the Corridor

In the spring of 2010, a team of planners at the University of Pennsylvania (UPenn) developed a proposal for a dedicated, two-track high-speed rail right-of-way running the length of the Northeast Corridor from Boston to Washington. The proposal called for frequent, 90-minute service from New York to Washington, DC, and 100-minute service from New York to Boston (figure 12). In a follow-up study in 2011, the UPenn team estimated that the proposal would cost $103 billion, including $14 billion in upgrades to the existing rail corridor, and found that the project had a strong benefit-cost ratio of 1.38 (University of Pennsylvania 2010; 2011).

Inspired by the original UPenn proposal, Amtrak developed its own "next-gen high-speed rail" plan that was made public in the fall of 2010. Amtrak also concluded that it would be feasible and beneficial to build a dedicated, two-track high-speed rail right-of-way along the length of the corridor, but choose a different alignment between New York and Boston. The estimated cost of the Amtrak proposal is $117 billion (Amtrak 2010a).

Both the UPenn and Amtrak proposals found that high-speed rail would generate a range of economic and mobility benefits for the Northeast Megaregion. The UPenn study also dealt with revitalizing the economies of the Northeast's weaker market cities. Both studies called for new stations to be developed in Center City Philadelphia and downtown Baltimore, which would create significant economic development potential in those cities.

The UPenn study also proposed that some of the capacity created by the new high-speed rail line be used to provide high-speed commuter rail services in the corridor, modeled after the successful Javelin service that utilizes capacity in the HS1 corridor in Southeast England. The combination of high-speed intercity and commuter services could expand and integrate commuter sheds and housing markets across the Northeast, increasing the economic productivity of the megaregion as a whole.

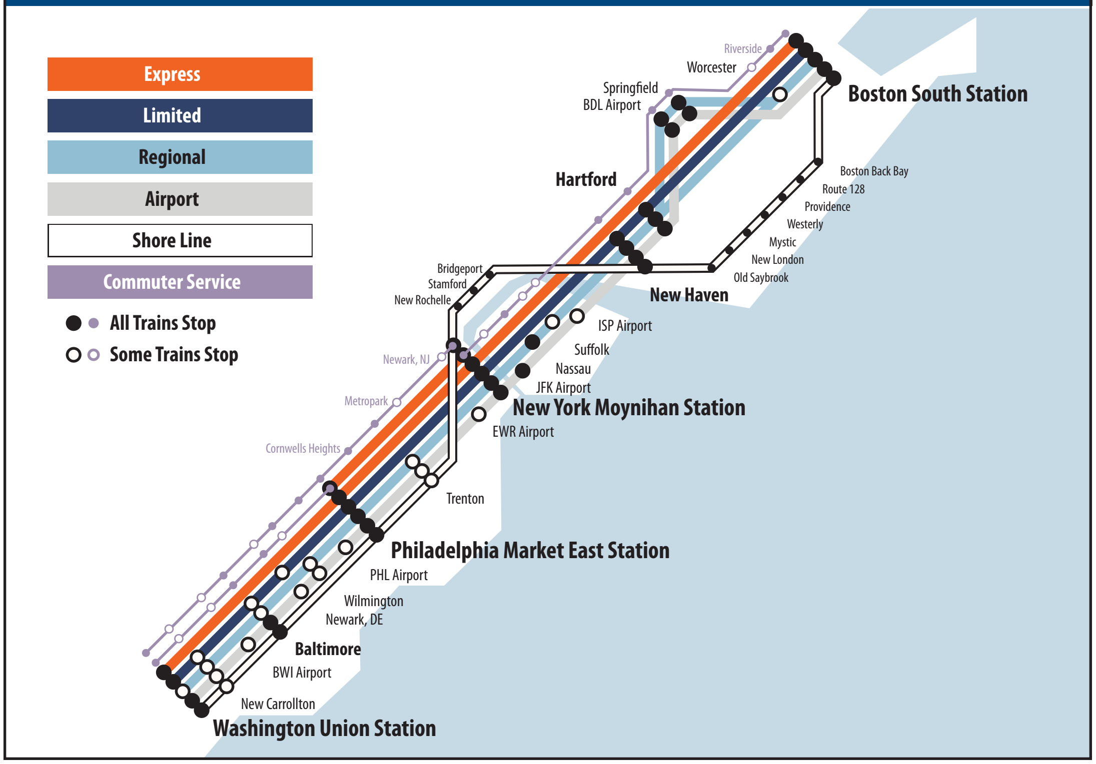
Governance and Operational Challenges

Two of the challenges facing the Northeast Corridor are its pattern of fragmented governance among eight states and the District of Columbia and the competing intercity and commuter rail services that share infrastructure and create congestion. The corridor has neither the capacity nor the alignment that would permit it to be used for Core Express high-speed rail service. At the same time, the existing infrastructure requires several billion dollars annually for necessary repairs and enhancements to increase capacity to meet projected demand for rail travel by 2030. Achieving both goals—to provide true high-speed rail service and meet the growing demand for commuter rail service—will require major new management structures and new investment.

To respond to these needs, PRIIA authorized the creation of the Northeast Corridor Infrastructure and Operations Advisory Commission, which is composed of representatives of the nine jurisdictions served by the corridor, U.S. DOT, FRA, and Amtrak, to collaborate on infrastructure and operational decisions on the corridor. While the new commission provides a venue for collaborative decision making, it does not restructure or consolidate ownership of the corridor or appear to fundamentally change the way the corridor is operated.

Reforms in the administration and operation of European high-speed and intercity

FIGURE 12
Proposed Northeast Corridor High-Speed Rail Service Plan



Source: University of Pennsylvania (2011, 57).

rail services suggest an alternative approach for the Northeast Corridor. The EU requires that national railroads unbundle their operating and infrastructure functions and provide open access to their rail lines, making it possible for public and private operators to offer competing services on the same lines. In most European examples, each country's national railroad has benefitted from its established position in the marketplace, although budding competition from new operators has encouraged entrepreneurial innovations. In practice, however, many routes continue to function as state-operated monopolies due to the challenges of providing multiple maintenance facilities on each route.

Spain's high-speed rail network separates operations and infrastructure responsibilities between RENFE, the national rail operator, and Adif, a company that has successfully developed over 2,000 miles of high-speed tracks and facilities. The United Kingdom's HS1 also provides an example of splitting operations from infrastructure management. In the Northeast Corridor it may be advantageous to take a similar approach of separating operations and infrastructure, particularly if the region chooses to embark on an ambitious plan of building two dedicated tracks for high-speed trains, as proposed by Amtrak and UPenn. Creating a publicly chartered infrastructure corporation for the Northeast Corridor to carry out this mission would relieve the dual burden currently borne by Amtrak to develop high-speed rail infrastructure and operate a sprawling national train network.

A megaproject of this magnitude is also likely to require a single-purpose entity with the appropriate staff expertise, financial transparency, and ability to attract private capital to carry out its mission. This entity would charge neutral and fair access fees to all train operators on the corridor, which would also provide a steady revenue stream that could be used to pay back infrastructure bonds and loans and to reinvest in the corridor.

Next Steps

Implementation of high-speed rail in the Northeast Corridor will be at least a decade behind the effort in California, where construction is scheduled to begin as early as fall 2012. Infrastructure costs in the Northeast Corridor are also considerably higher, with estimates ranging from $89 to $117 billion for a new, dedicated system, and between $14 and $52 billion for upgrades to the existing corridor (University of Pennsylvania 2011; Amtrak 2010a; 2010b).

Nevertheless, the $2.7 trillion economy in the Northeast (Bureau of Economic Analysis 2009), its high population density, and the growing congestion of its existing rails, roads, and runways all make a strong case for these investments. These dynamics also make dedicated high-speed rail in the Northeast financially viable. The UPenn study found that such a system could completely cover its operating costs and a portion of its capital costs through farebox and supplementary revenues (University of Pennsylvania 2011).

As in California, the path to high-speed rail in the Northeast Corridor will not be easy, but the federal government commitment to high-speed rail in 2009 and 2010 has inspired planners and policy makers to consider some of the steps that could lead to realizing a dedicated high-speed rail corridor with dramatically enhanced mobility for decades to come.

California's 2008 bond measure acted as a statewide referendum on high-speed rail, but there is no similar single mechanism for achieving a corridor-wide vote of confidence across the eight states and the District of Columbia in the Northeast Corridor. Building consensus among these jurisdictions and the federal government will require substantial research and public outreach, starting with studies that estimate the economic benefits of this project. Options for different alignments of the railroad also need to be evaluated for their relative ability to leverage rail investment for economic growth and minimize environmental impacts.

The National Environmental Protection Act (NEPA) requires an Environmental Impact Statement (EIS) for major transportation and infrastructure projects, but the review process often results in years of delay, adding to already high project costs. A programmatic EIS for improvements to the Northeast Corridor has been scheduled for 2011, to be led by the FRA in cooperation with Amtrak and the northeastern states.

The federal and state agencies should examine best practices for expediting the EIS process, such as those used for the redevelopment of the World Trade Center site. In that case, innovative project management techniques, memoranda of understanding, environmental performance commitments, and interagency partnerships significantly compressed the timeline for environmental regulatory review without sacrificing disclosure or environmental performance.

Based on the Spanish and English examples, separating operations from infrastructure management in the Northeast Corridor may be desirable, primarily because the cost and complexity of building a high-speed rail infrastructure project of this magnitude requires a financially viable single-purpose entity that could attract additional private capital. A publicly chartered infrastructure corporation would design, build, and maintain tracks, stations, dispatching, and other systems in

High-speed rail plans for the Northeast Corridor would locate a station in Center City Philadelphia.

the corridor, while one or more train operators would pay track access fees to operate intercity high-speed trains on both the existing corridor and the new dedicated tracks, once they are built.

The new Northeast Corridor infrastructure corporation could also enter into contracts with private concessionaires to design, build, and maintain portions of the project, such as segments of track infrastructure, tunnels, and bridges. A number of public-private partnership projects in Europe have been able to provide one-third or more of the total budget of high-speed rail projects from private sources, stretching public budgets in a time of fiscal austerity.

After the track infrastructure is built, the Northeast Corridor infrastructure corporation could also offer long-term lease arrangements for portions of the corridor's right-of-way, similar to HS1 Limited's lease to its investors, Borealis Infrastructure and the Ontario Teachers Pension Fund. This would have the effect of reimbursing the government for its initial investment in the project. Finally, Amtrak, the commuter railroads, and potentially other private rail operators would pay track access fees to provide high-speed intercity and commuter services with a range of price-points and services.

SUMMARY

Both California and the Northeast Corridor present strong cases for investment in high-speed rail in their large and growing economies. However, the path to realizing that vision is not yet clear. It will require securing reliable funding commitments based on credible evidence that benefits exceed costs. Without federal support, these and other regional high-speed rail projects are unlikely to secure the necessary state and private funding commitments needed to proceed.

CHAPTER 6
Funding and Financing Options for High-Speed Rail

U.S. Capitol, Washington, DC

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Like other modes of transportation and public goods, high-speed rail generally does not pay for itself through ticket fares and other operating revenues. Reliable federal funding is needed for some portion of the upfront capital costs of constructing rail infrastructure, but operating revenues frequently cover operating and maintenance costs.

Two well-known examples of highly successful high-speed rail lines—the Tokyo–Osaka *Shinkansen* and Paris–Lyon *TGV*—generate an operating profit (JR Central 2010; Gow 2008). German high-speed trains also have been profitable on an operating basis, with revenues covering 100 percent of maintenance costs and 30 percent of new track construction (University of Pennsylvania 2011).

Moreover, as long as the HSIPR Program combines funding for both high-speed and conventional rail, federal grants, not loans, will be required to support its initiatives. Since conventional rail services are likely to need continued operating subsidies, it is even more important to secure a federal funding source for capital infrastructure costs. A small but reliable transportation tax for high-speed and conventional passenger rail would demonstrate the federal government's commitment to a comprehensive rail program, giving states the assurance they need to plan high-speed rail projects and equipment manufacturers the confidence they require to invest in the industry.

The challenge of securing revenue for rail investments is closely linked to the challenge of funding the nation's entire surface transportation program. While in the past revenues from the federal motor fuel taxes were sufficient to cover the nation's highway and transit priorities, the 18.4 cents per gallon gasoline tax has been fixed since 1993, while the dollar has lost one-third of its purchasing power in that time (RAND Corporation 2011). New sources of sustainable revenue are needed to support not only high-speed and conventional passenger rail but also all of the nation's surface transportation obligations, including highways and transit.

In recent years, Congress has addressed the funding shortfall with short-term fixes by transferring general fund revenues to the highway trust fund. However, the need to find a long-term solution presents the opportunity to address existing surface transportation needs and high-speed and passenger rail all at once. At some point in the near future, Congress must address the shortfall in national transportation funding. At that time legislators could also dedicate revenues for high-speed and passenger rail as part of the surface transportation program, generated by a variety of small increases or reallocations of current transportation-related fees to provide at least $5 billion in annual funds. Several proposals are currently being considered.

- Raise the gas tax by 15 cents a gallon (The National Commission on Fiscal Responsibility and Reform, 2010) or more. Each additional cent of gas tax generates approximately $1.4 billion annually (AASHTO 2011). Several cents could be devoted to passenger rail.
- Add a $1 surcharge on current passenger rail tickets to produce approximately $29 million annually (Amtrak 2011d). Though this is a relatively small amount of revenue, it could become an important source of funds for expanding and maintaining the system as passenger rail ridership grows.
- Or, shift from a national gas tax to a percentage tax on crude oil and imported refined petroleum products consumed in the United States to fund all the nation's transportation needs (RAND Corporation 2011). RAND estimated that an oil tax of 17 percent would generate approximately $83 billion a year (at midsummer 2010 prices of $72 per barrel). Five billion dollars of this amount could be dedicated to passenger rail.

Alternatively, if the federal government switched from the current gas tax to a tax based on vehicle miles traveled (VMT) and two-tenths of a penny per mile were dedicated to passenger rail, $5.4 billion could be generated every year (U.S. DOT 2011d). The VMT tax as a source of transportation funding is supported by many transportation policy leaders, but has been disavowed by the Obama administration (Laing 2011b).

Former Interior secretary and Arizona governor Bruce Babbitt has proposed that a gasoline tax surcharge in the Northeast Corridor states could pay for high-speed rail in that region (Langdon 2011). This alternative has the advantage of explicitly linking the revenue sources to beneficiaries of the system. Other regional taxes, such as a payroll tax on businesses along the corridor, could also be considered. Such a tax is now used in downstate New York to help fund New York City Transit.

Any of these options will face the difficult reality of the current political climate centered on austerity, in which large new infrastructure investments are easy targets for trimming government budgets. Under these conditions, direct government funding alone will not be sufficient to develop high-speed rail. Innovative financing solutions will require both the expansion of government subsidized financing options and private financing initiatives.

GOVERNMENT FINANCING TOOLS

High-speed rail in Europe has been funded and financed by a variety of sources, including national governments and EU structural funds. The European Investment Bank (EIB) provides subsidized loans with favorable interest rates and long repayment periods, as well as loan guarantees and direct recruitment of private lenders. While the United States currently does not have an equivalent to the EIB, President Obama has proposed a national infrastructure bank that could play a similar role in providing loans, grants, and credit assistance for transportation projects at a regional or national scale. The president also proposed capitalizing the bank with $30 billion in the FY 2012 federal budget (White House 2011).

Some states already have their own state infrastructure banks, which operate on a system of revolving direct loans to increase the overall number of projects that can be built with limited federal transportation funds (Ohio Department of Transportation 2011; Wisconsin Department of Transportation 2011). A national infrastructure bank, and to a lesser degree the state banks, could provide crucial funding and financing assistance for the large upfront costs, while encouraging collaboration among the state, local, and private investors involved in the construction of high-speed rail lines.


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Two existing federal loan programs for transportation also could be expanded for high-speed rail financing. The Transportation Infrastructure Finance and Innovation Act (TIFIA) provides long-term loans and credit assistance through the U.S. Department of Transportation to finance large infrastructure projects with dedicated revenue sources that allow repayment. The program is designed to leverage private co-investment, and can cover up to 33 percent of the project costs (U.S. DOT 2011b).

TIFIA could encourage even greater private investment if the program were enhanced to increase the maximum funding allowed to reflect current demand; permit more flexibility in the project costs that can receive funding; and offer a simplified application and review process (Yarema 2011). These enhancements would be beneficial for funding high-speed rail since the costs are large and lead times are already long, even before the time for required review processes is added.

The Railroad Rehabilitation and Improvement Financing (RRIF) Program provides direct federal loans and loan guarantees to finance the development of railroad infrastructure. It is beneficial for high-speed rail because it can supply direct loans for up to 100 percent of project costs, with repayment periods up to 35 years and low interest rates locked in for the life of the loan term. To date, the program has been utilized primarily by small and medium-sized private railroads (U.S. DOT 2011c). Rail advocates have suggested modifying the stringent collateral requirement and credit risk premiums to make RRIF work for high-speed rail, as well as making high-speed rail's eligibility explicit in the criteria (AHSRA 2011b).

PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships (sometimes referred to as P3s) generally constitute any arrangement between a government sponsor and a private sector entity in which the private entity provides one or more stages of the project delivery process—designing, building, operating, owning or leasing, maintaining, and financing parts of the infrastructure. These partnerships offer the benefit of flexibility to suit the specific needs of the public sector while encouraging different models of private involvement and investment (Geddes 2011).

Public-private partnerships are considered an especially attractive solution for financing infrastructure projects. For example, the Florida Department of Transportation was already in the process of finding a private partner to design, build, operate, maintain, and finance the state's high-speed rail line before the project was cancelled in February 2011 (Haddad 2010).

While public-private partnerships are likely to increase in popularity as an option for cash-strapped governments, applying this approach to high-speed rail must be done carefully, with a realistic understanding of the benefits and challenges.

Sharing risk: Partnerships allow the public sector to share project risks related to construction, environmental review, system performance, and ridership with their private partner. Properly assigning risk to the party best able to manage it is critical to a successful project. In general, private partners are better able to control construction and financing risk, and public partners are better able to manage political and entitlement risk. Ridership risk is shared by both parties, with the opportunity for both to benefit when ridership exceeds expectations. Attention to the private entity's susceptibility to market downturns is also important. The private entity should not shoulder so much risk that it could endanger its ability to live up to the terms of the contract.

Leveraging public investment: Leveraging public investment with private capital, either through the use of federal financing tools or availability payments, can help pay for high-speed rail's large upfront costs. These mechanisms make large projects feasible without the need for the government to provide 100 percent public funding in advance.

Federal financing tools include qualified tax credit bonds such as Build America Bonds, which can draw a wide variety of investors to contribute to transportation projects. Availability payments allow teams of construction and finance firms to begin construction of infrastructure projects through their own debt and equity. They later receive reimbursements from the government as particular milestones are reached.

Faster project delivery: Private entities can draw on experience to deliver projects on time and on budget. They are also motivated by financial incentives for performance (including availability payments), which can be written into the structure of the deal.

Two ends of the spectrum of private sector involvement in public-private partnerships are design-bid-build agreements (DBBs) and design-build-finance-operate-maintain agreements (DBFOM). DBB is considered the traditional method for construction project delivery. The public entity chooses a design proposal from private architects and engineers in the design phase, and then accepts a bid from a private construction firm to build the project. The design and build processes occur independently with different private partners, and the public sector handles all financing, operations, and maintenance.

DBFOM takes the DBB approach several steps further by having a single private partner design and build the infrastructure project, and also assume additional responsibility for its operations and maintenance, as well as some of the responsibility and risks of financing it. The government awards a concession to the private entity, or concessionaire, usually a consortium of private companies, for a determined length of time and often over decades. The concessionaires provide funding, often through their own investors, although substantial government funding is also required.

Concessionaires are eventually compensated through payments from the government, either on a yearly basis or as availability payments, based on performance standards and milestones. Concessionaires can also receive payments from user fees, such as ticket fares and track access charges. This approach could be used for high-speed rail because it is the model that shares the most risk with the private entity and also incentivizes a project of continuing quality.

Many other public-private partnership models exist, including those with little risk assumed by the private sector, such as design-build (DB), and those with substantial post-construction commitments from the private sector, including build-operate-transfer (BOT), long-term lease (LTL), and build-own-operate (BOO), all of which give the private sector a degree of ownership over the infrastructure project for a specified period of time.

The following case studies illustrate different variations of public-private partnerships in four countries.

High Speed 1 (HS1), England

The HS1 line connects the Channel Tunnel with St. Pancras International, the London terminus of the high-speed Eurostar trains

The St. Pancras International Station in London.

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that link the United Kingdom with Paris, Lille, and Brussels. HS1 was developed initially as a public-private partnership in which a private consortium began building the rail line. However, midway through construction, the partnership collapsed and was taken over by the British Department for Transport, which created a shell corporation, HS1 Limited, to complete construction and begin operating the rail line. HS1 Limited opened the unused capacity of the route to the Javelin high-speed commuter rail service from a number of cities in Kent, providing London's southeastern suburbs with improved access to the city. HS1 is also negotiating with *Deutsche Bahn* to provide high-speed trains from Germany with direct access into St. Pancras.

Following the completion of HS1 and the successful initiation of Eurostar and Javelin services, HS1 Limited conducted a tender offer for a private consortium to enter into a 30-year lease to operate and maintain the rail corridor. In 2010 Borealis Infrastructure and the Ontario Teachers Pension Fund signed a $3.8 billion contract to operate and maintain the HS1 corridor, returning approximately one-third of the total construction cost to the British Treasury (HS1 Limited 2011). Those funds are now being used for other transportation needs in Britain (Railway Technology 2011).

Profits to the concessionaire are derived from farebox revenues from Eurostar, other passenger services, and track access charges to other rail lines, including high-speed freight. These revenues cover the operations and maintenance costs.

Taiwan High-Speed Rail

The case of Taiwan High-Speed Rail exemplifies certain risks of using public-private partnerships to build high-speed rail and demonstrates the importance of choosing an appropriate private partner, properly allocating risk, and accurately projecting construction costs and ridership.

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Taiwan's high-speed trains deliver passengers to its major cities.

In 1997, the government of Taiwan entered into a 35-year DBFOM concession for the high-speed rail line and a 50-year concession to development the land around its stations with the Taiwan High-Speed Rail Corporation (Shima 2007). Several years after it was originally scheduled to open, the corporation finally completed construction of the line in 2007, with a north-south track running along the west coast of the island to connect the country's two largest cities, Taipei and Kaohsiung.

Plagued by lengthy delays and cost overruns, the corporation amassed enormous amounts of debt (Ho 2004). Once in operation, the service failed to meet overly optimistic ridership projections and accumulated operating losses. Eventually, the corporation was unable to repay the loans it had encumbered to build the line. In 2009, the Taiwanese government intervened, refinanced the corporation's debt, restructured the board of directors, and effectively took over the corporation's franchise (Huang 2009; *Railway Gazette International* 2009).

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Denver is financing its FasTracks regional transportation plan with a mix of federal, local, and private funding sources.

Eagle P3 Project, Denver, Colorado

This current U.S. example of a public-private partnership for funding rail transit includes the creation of three commuter rail lines to be added to Denver's FasTrack system—a regional network of light rail and bus rapid transit lines. The Eagle P3 Project operates under an agreement between the government authority, the Regional Transportation District (RTD), and a private concessionaire, Denver Transit Partners (DTP). DTP is a consortium of investment, construction, and engineering firms created especially for this partnership. The concession agreement requires DTP to design, build, finance, operate, and maintain the three new commuter lines, which will have 36 miles of track and 15 stations.

DTP completed the contract with RTD in 2010 for a six-year design-build phase to be followed by a 30-year concession of operations and maintenance. It requires approximately $450 million in private financing from DTP, which will be paid back by RTD through construction and service milestone payments. Construction is scheduled between 2012 and 2015, and the three new rail lines should be operational by 2016 (Podkul 2010).

DTP projected a total capital cost of $2.1 billion, which was $300 million less than the RTD's capital budget estimate. This low cost estimate was one factor in DTP's selection as the concessionaire. While a significant amount of risk is shifted to DTP, strong funding support is still required from multiple government entities. The project will depend on a contribution of about $777 million from RTD, funded in part by a voter-approved 0.4 percent sales tax in the multiple municipalities served by the transit system. RTD is also anticipating a $1 billion grant award from the Federal Transit Administration (Regional Transportation District 2010).

Vancouver's Canada Line

This case exemplifies a rail transit project that has completed construction and successfully entered the operations phase. It is a partnership between the federal, provincial, and city governments, the Vancouver Airport Authority, and the private partner, InTransitBC, which is a joint venture company owned by three Canadian corporations. Built in anticipation of the 2010 Winter Olympics, the line connects downtown Vancouver to the Vancouver Airport and the nearby city of Richmond. The 16 stations and 12 miles of track are part of TransLink, the regional transportation authority and public transportation system.

Canada Line Rapid Transit Inc. (CLCO) was established as a wholly owned subsidiary of TransLink to serve as the government entity of this partnership under a 35-year concession agreement. InTransitBC was paid by CLCO based on milestones in the construction process, and continues to receive performance-based operating payments. The agreement involved a detailed risk allocation: CLCO assumed responsibility for right-of-way acquisition and utilities relocation; InTransitBC assumed the risk of construction costs and systems performance; and both partners shared risks such as ridership and revenue, environmental and regulatory approvals, and inflation during operational periods (Cummings 2010). The project was completed in August 2009, three months ahead of schedule, and has exceeded its original target ridership projections (Luba 2010).

Like Denver's Eagle P3 Project, the Canada Line received both private financing and dedicated government funding. InTransitBC raised a total of $720 million for its capital contribution, compared to $450 million raised by the Canadian government, $435 million by the British Columbia provincial government, $300 million by the Airport Authority, $334 million by TransLink, and $29 million by the City of Vancouver. InTransitBC raised the equity from its three shareholder companies and arranged debt financing secured over a 28-year term from its lenders (Cummings 2010).

SUMMARY

A sustainable funding strategy, including reliable federal commitments, is needed to put the HSIPR Program on a firm footing and inspire confidence among states and the private sector. This strategy can make use of a variety of public and private financing tools that leverage net revenue streams generated by high-speed rail operations. When approaching public-private partnerships, a proper allocation of risk among the parties is critical to a successful project.

The Canada Line light rail in Vancouver, British Columbia, was built and financed through a successful public-private partnership.

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CHAPTER 7
Recommendations for High-Speed Rail in the United States

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Curving tracks on the Northeast Corridor's approach to Philadelphia, Pennsylvania, require trains to slow down.

The United States is in a position to learn from many countries that have planned, built, and operated high-speed rail systems over the past four decades. Their experiences, coupled with an analysis of the potential benefits of high-speed rail for U.S. travel behaviors, land use patterns, and urban and regional economies, contribute to the following policy recommendations.

STRENGTHEN THE FEDERAL POLICY AND MANAGEMENT FRAMEWORK

The Passenger Rail Investment Improvement Act (PRIIA) is well-suited to support incremental investments in conventional passenger rail corridors, but it does not provide a sufficient policy or management framework to achieve the potential benefits of Core Express high-speed rail. Building on that act, an expanded federal role is needed to plan, prioritize, and commit to investments in high-speed rail and overcome the challenges of managing multistate capital programs and operations. Rather than wait for states to submit applications for federal funding for high-speed rail, the federal government should identify corridors with the greatest chance of meeting its goals and work with the states to secure rights-of-way for implementation.

PRIORITIZE CORRIDORS THAT MEET INVESTMENT CRITERIA

Federal decision makers should prioritize high-speed rail investments in corridors that exhibit regional characteristics that contribute to ridership demand, including population density, employment concentrations, transit connections, existing airline markets, and congestion on parallel road corridors. Federal planners should analyze both the benefits expected to be generated in specific corridors and the cost estimates for construction and ongoing operations. The respective roles of high-speed Core Express corridors and conventional Regional and Emerging/ Feeder routes need to be clarified, with well-defined objectives for each type of rail service.

ESTABLISH NEW MECHANISMS FOR CORRIDOR MANAGEMENT

A successful national high-speed rail program requires the involvement of entities capable of planning, financing, building, and operating multistate corridors. Federal legislation should be developed to enable the creation of publicly chartered infrastructure corporations capable of entering into public-private partnerships for corridors that span multiple states and even binational territories.

PLAN FOR MAXIMUM LAND DEVELOPMENT BENEFITS

To reap the greatest benefits, high-speed rail investments should be coupled with policies that encourage land development around rail stations. Careful planning must be undertaken for track alignment, station location, and connections with other transportation modes. In general, well-connected stations in center-city locations, when coupled with other investments, offer the greatest potential for urban revitalization.

Peripheral station locations should be avoided, as they are rarely successful in maximizing transportation and other land development benefits and may have negative impacts on center-city station areas. Although high-speed rail service by itself will not necessarily induce development, it can contribute to the success of a larger urban redevelopment plan that includes collateral investments and policies.

FOCUS ON THE NORTHEAST CORRIDOR AND CALIFORNIA

The Northeast Corridor and California offer the best opportunities for initial high-speed rail service, but management and financing challenges remain.

In the Northeast, it may be desirable to separate the corridor's operations and infrastructure functions in order to attract private capital and create a single-purpose entity capable of carrying out an ambitious high-speed rail plan. A Northeast Corridor infrastructure corporation would design, build, and maintain tracks, stations, dispatching, and other systems, while one or more train operators would pay track access fees to operate intercity high-speed trains once the new line is built.

The infrastructure corporation could enter into long-term lease arrangements for portions of the right-of-way, and public-private partnership agreements could be developed for major pieces of infrastructure, such as tunnels and bridges. Finally, the infrastructure corporation could contract with Amtrak and private operators to provide competing high-speed intercity and high-speed commuter services in the corridor, offering travelers a range of price-points and services.

SECURE ADEQUATE AND RELIABLE FUNDING

While passage of the American Recovery and Reinvestment Act in 2009 marked a new period of federal funding for high-speed and passenger rail, the elimination of funds for the HSIPR Program in the FY 2011 budget underscores the need for a sustainable revenue source to ensure

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long-term success. Such a commitment will not be possible with unpredictable appropriations, which have ranged widely from $8 billion in 2009 to negative $400 million in 2011.

The need to find a long-term solution for the nation's transportation funding presents the opportunity to address existing surface transportation needs and high-speed and passenger rail at the same time. When Congress addresses the current shortfall in transportation funding, it should also dedicate funding for passenger rail, such as by raising the gas tax by 15 cents and directing several cents to rail, or considering new approaches entirely—such as an upstream oil tax or VMT fee.

A national infrastructure bank could provide loans, grants, and credit assistance for transportation projects at a regional or national scale, covering large upfront costs while encouraging collaboration among state, local, and private investors. Two existing federal loan programs for transportation, TIFIA and RRIF, could be expanded for financing high-speed rail, and new programs such as Build America Bonds and other qualified tax credit bonds could attract a wide range of private investors.

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America 2050 is a national planning initiative to develop a framework for America's future development in the face of rapid population growth, demographic change, and infrastructure needs in the twenty-first century. A major focus of America 2050 is the emergence of megaregions—large networks of metropolitan areas where most of the population growth by mid-century will take place—and how to organize governance, infrastructure, and land use planning at this new urban scale. A project of Regional Plan Association, America 2050 is working to shape and support the new federal High-Speed Intercity Passenger Rail Program because of high-speed rail's potential to realize the economic promise of megaregions and act as a transformative investment for America's future growth.

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High-Speed Rail
International Lessons for U.S. Policy Makers

High-speed rail has been adopted throughout the world, and is now being planned and developed in the United States. Over the past 50 years, U.S. transportation spending has favored the development of interstate highway and aviation systems. In the meantime, countries such as China, Japan, Spain, France, and Germany have been investing in modern high-speed rail systems to satisfy the travel demands of current and future generations. As the United States embarks on the High-Speed Intercity Passenger Rail Program launched in 2009, it can learn from the experiences of other countries in planning, constructing, and operating high-speed rail.

Decades of international experience with high-speed rail suggests that it could create similar transportation, economic, environmental, and safety benefits in American cities and regions. While it requires high upfront investment, high-speed rail promotes economic growth by improving market access, boosting productivity of knowledge workers, expanding labor markets, and attracting visitor spending. When planned thoughtfully with complementary investments in the public realm, high-speed rail can promote urban regeneration and attract commercial development, as shown in several European examples. High-speed rail has greater operating energy efficiency than competing modes and takes up less land than highways.

This report describes several funding strategies that have proven to be successful in other countries, and makes specific policy recommendations to better position the federal high-speed rail program for success.

- **Strengthen the federal policy and management framework** by expanding the federal role in planning and prioritizing high-speed rail corridors and working with the states to secure rights-of-way.
- **Prioritize corridors that meet investment criteria** by clarifying the objectives and desired outcomes of the federal program and promoting investments in those corridors that exhibit the characteristics that are indicative of success.
- **Establish new mechanisms for corridor management** by developing legislation that enables the creation of public infrastructure corporations that can operate across state and national borders and attract private investment.
- **Plan for maximum land development benefits** by coupling high-speed rail station investments with policies that encourage land development around station areas. In general, well-connected stations in center-city locations offer the greatest potential for urban revitalization.
- **Focus initially on the Northeast Corridor and California,** which offer the best opportunities for Core Express high-speed rail service in the United States, by addressing the management and financing challenges each region faces.
- **Secure adequate and reliable funding** by drawing on potential federal, state, and private sources. Such sources could include increasing existing transportation-related fees (such as a portion of the gas tax or ticket surcharges), creating an infrastructure bank, forging public-private partnerships, and expanding existing credit assistance programs.

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